

Insulation



Circuit failures . . . page 30

In this issue: International standardization . . . page 10
Corona and polymers . . . page 25
Foams . . . page 34
Improving capacitor paper . . . page 42
Armature bands . . . page 44

SOME THINGS ARE JUST NATURALLY COMPATIBLE



LIKE BH ACRYLIC SLEEVINGS AND WIRE ENAMELS

Like Antony and Cleopatra, wire enamels and Bentley-Harris acrylic sleeveings were made for each other. BH Acryl-A and BH Acryl-C are new acrylic-resin coated fiberglass sleeveings just introduced by Bentley-Harris.

Both offer better than Class B protection at Class A cost, plus these advantages:

UNLIMITED COMPATIBILITY with wire enamels such as polyester, epoxy, formvar, etc. Under extensive testing, commercial magnet wire remains unaffected at accelerated heat-aging temperatures ranging from 180°C to 280°C. Check for yourself! Test procedure used and twisted pair specimen available on request.

EXTENDED HEAT LIFE has been proven through testing, using one-half of the initial rated dielectric breakdown value as the end point. At 130°C, up to 50,000 hours. At 155°C, up to 10,000 hours.

BH Acryl-A and BH Acryl-C offer flexibility that rivals vinyl-glass, and at comparable prices. They are craze-resistant and will not hydrolize.

These few facts just skim the surface of the advantages offered by Bentley-Harris acrylic sleeveings. Send for data sheet and sample sleeveings to get the complete story. Do it now!

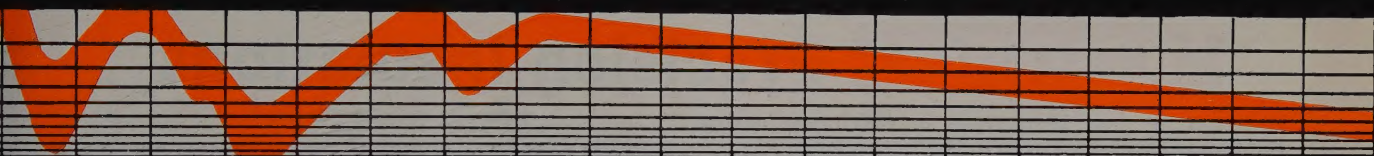


BENTLEY-HARRIS MANUFACTURING CO.
500 BARCLAY STREET CONSHOHOCKEN 6, PA.
Telephone: TAYlor 8-7600

Print Ins. 1 on Reader Service Card

Print Ins. 2 on Reader Service Card

HOW TO FLATTEN OUT YOUR INSULATION MATERIAL COST CURVE



In spite of other constantly rising prices, there are ways to level out your electrical insulation material costs . . . even to reduce them in some instances. One way is to substitute more economical materials—without any sacrifice of important property standards. Another way is to eliminate high labor cost production and assembly methods through the use of different materials.

Not only a specialist knows all the materials which can meet the requirements of your application . . . new products that are available . . . and how changes in materials have permitted other companies to achieve cost-cutting production economies. Dozens of factors enter the cost picture—for example, one material may be better and more expensive yet save you money because less material is needed. All these factors are known to Prehler men. This is natural because Prehler sells nearly every conceivable type of insulation to provide the widest possible selection. What's more, Prehler has direct contact with the laboratories of the leading insulation producers—Prehler is familiar with new materials which are advanced and which may help you to cut your costs and improve your products. And, Prehler men have been contacting companies such as yours for years—this experience has given them a storehouse of hundreds of ideas for cutting production costs.

Take advantage of Prehler's unique ability to flatten out your cost curve—call your nearest office, today.

PREHLER ELECTRICAL INSULATION CO.



Chicago 39, Ill., 2300 N. Kilbourn Ave., **EVERglade 4-6100**

Branch Offices

Cleveland 30, Ohio, 12200 Brookpark Rd., **CLEARwater 1-1800**

Detroit 2, Mich., 411 Piquette Ave., **TRinity 5-4020**

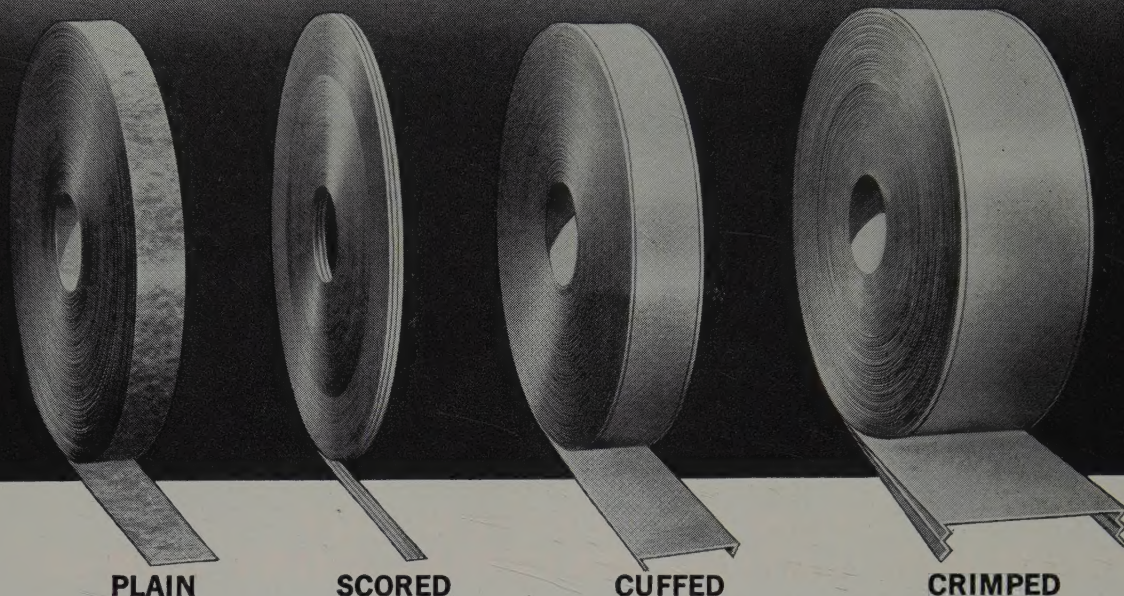
St. Paul 1, Minn., 367 Grove St., **CAPital 5-4321**

Milwaukee 12, Wis., 3379 N. Green Bay Ave., **FRanklin 4-3100**

Dayton, Ohio, **BALdwin 2-0574**

(Use Cleveland Address)

BULK-PACK COILS IN FOUR DIFFERENT STYLES



Inmanco® Precision Insulations

Here are the four basic styles in which you can get INMANCO bulk-pack coils in production lengths:

PLAIN—Precision slit INMANCO coils, fabricated with machine feeding in mind. Coils are hard . . . feed uniformly through automatic inserters . . . give max. yield per roll.

SCORED—Precision slit then scored with one or more scores or creases to permit easy bending when used on the production line as separators between windings.

CUFFED—A bulk stock of given width between cuffs from which slot insulators of various depths can be cut, creased, scored, or formed. Usually single-cuffed coils are used, but double-cuffed are available. Both greatly improve edge tear resistance.

CRIMPED—For transformer layer insulation applications. Have accordion pleats or folds along one or two parallel edges to obtain a barrier at the edge which prevents windings from falling off.

Standard rolls are approximately 15" in diameter, wound on cores of 1½", 1¼", 2", and 3" I.D. Normal tolerances in widths are ±2% for widths under 1", and ±½% (or 1%, whichever is greater) for coils over 1" wide. The table at right lists the most popular styles and materials. However, the scope of INMANCO's modern facilities can supply you with the exact put-up, size, and material needed for practically any application. Call in an INMANCO representative on your next job or send specifications and inquiries to your nearest IMC office.

NORMAL RANGE OF WIDTHS

PLAIN COILS—¾" and up (in any thickness) except Mylar† and Mylar combinations which start at ⅛".

SCORED COILS—¾" and up (in any thickness) except Mylar† and Mylar combinations which start at ⅛".

CUFFED COILS—⅞" to 10" between cuffs.

CRIMPED COILS—⅞" to 24" between crimps.

Material	Plain	Scored	Cuffed	Crimped
All Rag Papers	Yes	Yes	Yes	Yes*
Tan Electrical Kraft Papers	Yes	Yes	Yes*	Yes*
Fibre (Fishpaper)	Yes	Yes		
Paper-Varnish Cambric Combination	Yes	Yes	Yes*	
Mylar† Film	Yes	Yes*	Yes*	
Mylar†-Dacron† Matte Combinations	Yes	Yes	Yes	
Mylar† Asbestos	Yes	Yes	Yes	Yes*
Mylar†-Paper Combinations	Yes	Yes	Yes	Yes*
Acetate-Paper Combinations	Yes	Yes	Yes*	Yes*

*Depending on thickness †DuPont trademark

Made by
Inmanco®
DIVISION

INSULATION MANUFACTURERS CORPORATION

565 West Washington Boulevard, Chicago 6, Illinois

Branch Offices, Representatives, and Distributors in Principal Cities

Print Ins. 3 on Reader Service Card



Insulation

For the Electrical and Electronic Industries

Lake Publishing Corporation, 311 East Park Avenue, Libertyville, Illinois, May, 1961
Publishers of *Insulation*, *Insulation Directory/Encyclopedia Issue*, *Plastics Design & Processing*

- 19 *New Developments in Epoxy Resins—Part 6*
Henry Lee and Kris Neville
- 25 *Degradation of Polymers*
By External Corona Discharge
R. F. Grossman
- 30 *The Folklore of Encapsulation*
R. Engquist, R. Feuchtbaum, and F. Keister
- 34 *Foams and Low Density Compounds*
Charles A. Harper
- 42 *Test Methods and Apparatus*
For Improving Capacitor Paper
L. W. Stiles and J. D. Stacy
- 44 *Tests Show Suitability of Resin-Glass Fiber*
Armature Bands for Metal-Rolling-Mill Drives
R. W. Stevens
- 60 *Store Transformer Oil*
In Fabric Tanks
During Maintenance
- 60 *More Accurate Radio*
Frequency Broadcast
- 60 *Removable Printed*
Circuit Wafer

- 4 *From the Editor*
- 8 *News and Views*
- 10 *Insulation Forum*
- 46 *European Insulation Report*
- 51 *Pixilated Patents*
- 54 *New Publications*
- 56 *People in the News*
- 63 *Letters to the Editor*
- 64 *Association News*
- 70 *Industry News*
- 72 *New Materials and Components*
- 84 *New Instruments and Equipment*
- 90 *New Literature*
- 96 *Dates to Circle*
- 97 *NEMA Electrical Insulation Index*
- 98 *Advertisers' Index*

Editor and Publisher: Lincoln R. Samelson

Associate Editors: Richard D. Simonson, George V. Michael

Assistant Editor and Production Manager: F. P. Mignin

Contributing Editors: Graham Lee Moses, H. K. Graves, Mike Rivise

Art Director: Randall R. Roth

Circulation Policy and Subscriptions: *Insulation* is distributed without charge within the United States to qualified users of electrical and electronic insulating materials engaged in design and specifying work covering the use of insulation. Subscription rates to others within the United States, Canada, and U.S. Possessions are \$1.25 per copy, \$12.50 per year, and \$20.00 for two years. Rates for other countries are \$25.00 per year, \$45.00 for two years.

Circulation requests and inquiries should give title or department, company name, and products or services of company. Corrections should also show old company name and address.

Back Issues, when available, are charged for at the rate of \$1.50 per copy for 1 to 10 copies and \$1.25 per copy for 10 or more copies for requests from within the United States, Canada, and U.S. Possessions; \$2.50 per copy to all other countries.

Copyright, 1961, by Lake Publishing Corp. Reproduction of text and illustrations not permitted without permission of copyright owners.

Opinions expressed in this publication by authors are not necessarily those of the publishers and this publication can accept no responsibility in connection with any liability which might develop as a result of articles published.

Insulation, May, 1961, Volume 7, Number 5. Published monthly, except twice a month in May, by Lake Publishing Corp., Box 270, 311 E. Park Ave., Libertyville, Ill. Phone EMpire 2-8711.

Accepted as controlled circulation publication at Mount Morris, Illinois.



Member Business Publication Audit of Circulation, Inc.

Advertising Sales Offices: See page 98.

From the Editor

Opinions and Rambling Thoughts

Watch for the Insulation Directory/Encyclopedia

Within the next month you'll receive the first issue of the *Insulation Directory/Encyclopedia* issue which is our most ambitious publishing effort to date. To be published annually, this first issue will contain close to 350 pages.

For the first time anywhere, the ID/E issue brings together all of the available basic information on insulation concepts, standards, materials, wire and cable, plastics, insulated components, test instruments, and production equipment. To our knowledge, it is the most comprehensive treatment of the subject which has ever been published. In addition, it provides listings of all the manufacturers and distributors who replied to questionnaires.

As you undoubtedly have gathered, we think the ID/E is nothing short of terrific. It is something which has been talked about for years and finally is a reality. It is a reference book which all insulation users will want to keep within reach for daily use.

There already are improvements in the ID/E which are being planned for next year—improvements which are difficult to accomplish in a first issue or which are not obvious until the printed version is available (in contrast to the typewritten copy).

As with all such projects, we did not realize what a huge task the ID/E was until we actually started it. Part of the problem was the vast store of information on insulation which *was not available*. The ID/E fills this void—even the most sophisticated insulation engineer or scientist will find materials covered which he never considered as being used for electrical/electronic insulation. Another part of the problem, of course, was the searching, gathering together, organizing, and assimilating of information and data from thousands of different sources. Our office is normally not too neat but it was a complete mess at

the height of our work on the ID/E. We finally decided that the best way to organize things was to make 27 separate piles on the floor (representing 27 sections or chapters). There was a sigh of relief as each pile disappeared.

In preparing the ID/E issue, we had splendid cooperation from individuals, companies, and associations and trade groups—to them should go much of the credit. We are very grateful for this help.

As previously mentioned, we did not fully know what we were getting into when we decided to go ahead with the ID/E issue. It is fortunate that this is so or many such projects might never get started. We have learned one thing from all this and that is to not get involved in two similar endeavors at the same time unless you are prepared to give up sleeping for a year—twins are twice as hard. In our case, the twins were ID/E and *PLASTICS DESIGN & PROCESSING*, our new monthly publication for the processors and volume manufacturing users of plastics, which first appeared in April. Anyway, both publications are now well on the road and we swear we won't do it again . . . until the next time.

Just one other thought on the ID/E, after you have had a chance to examine it, please write and let us know what you think of it. We're interested in both compliments and brickbats so that we can continue to improve it. Tell us what you like about it and make suggestions for increasing its value to you. We'll appreciate it.

New Development Odds and Ends

You might be interested in some of the following odds and ends of new developments which have come to pass or will come to pass—all designed to make your life easier, better, or more complicated. We put the news release announcements on such items to one side as they come in, saving them up for a time such as this.

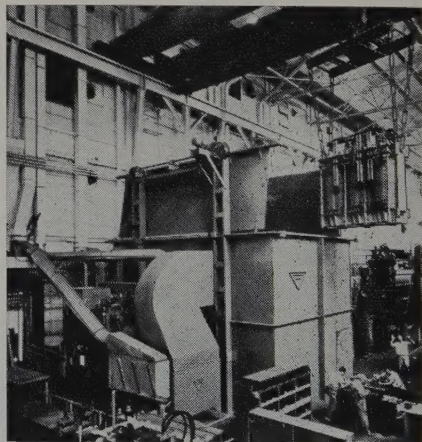
In England at the March Tenth Electrical Engineers Exhibition, the world's largest moving coil meter, about 17 feet square, was used to show the total electrical load connected during the exhibition. If he came upon it rather suddenly, such a meter might be enough to make a drunken engineer take the pledge.

Out in Spokane, Wash., the Washington Water Power Co. reports a simple and practical idea—they wrap utility poles with aluminum foil to

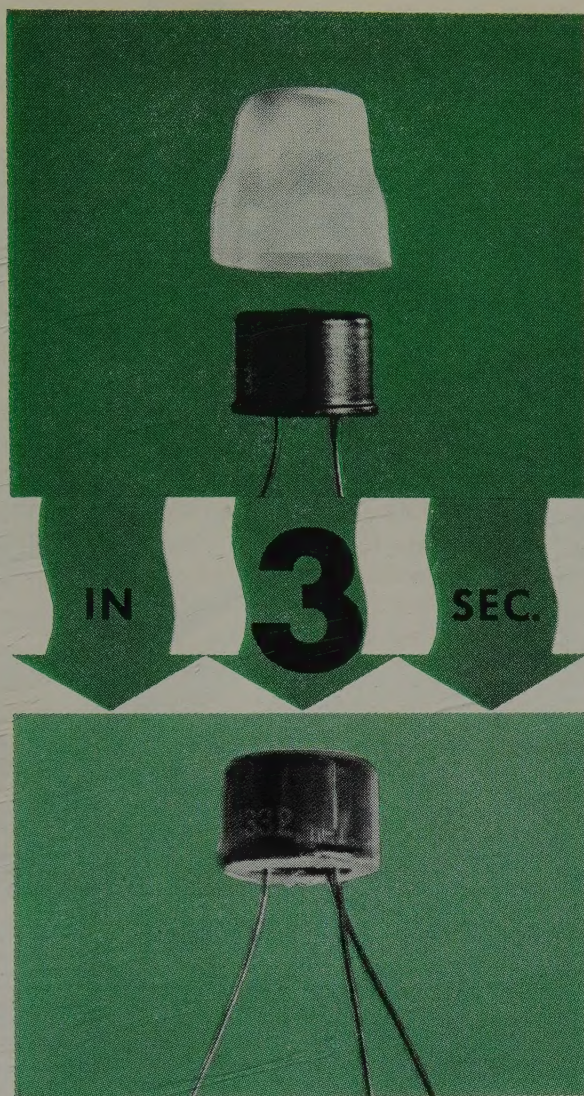


prevent damage from grass fires. The only hitch that we can see is that they might need a thousand-dollar concrete bunker to stop the kids from tearing it off.

If your wife complains that her oven isn't large enough you might show her this next photo to illustrate what some cooks have to go through just to bake a transformer. That's a 75-ton overhead crane which is about



to lower a transformer into a 15' by 22' by 17½' oven at Wagner Electric Co. The Despatch oven is rated at 250°F max. There is a complete change of air every 3⅓ minutes.



heat shrinkable

THERMOFIT[®]

PREFORMED COVERS



RAYCLAD[®] TUBES
INCORPORATED

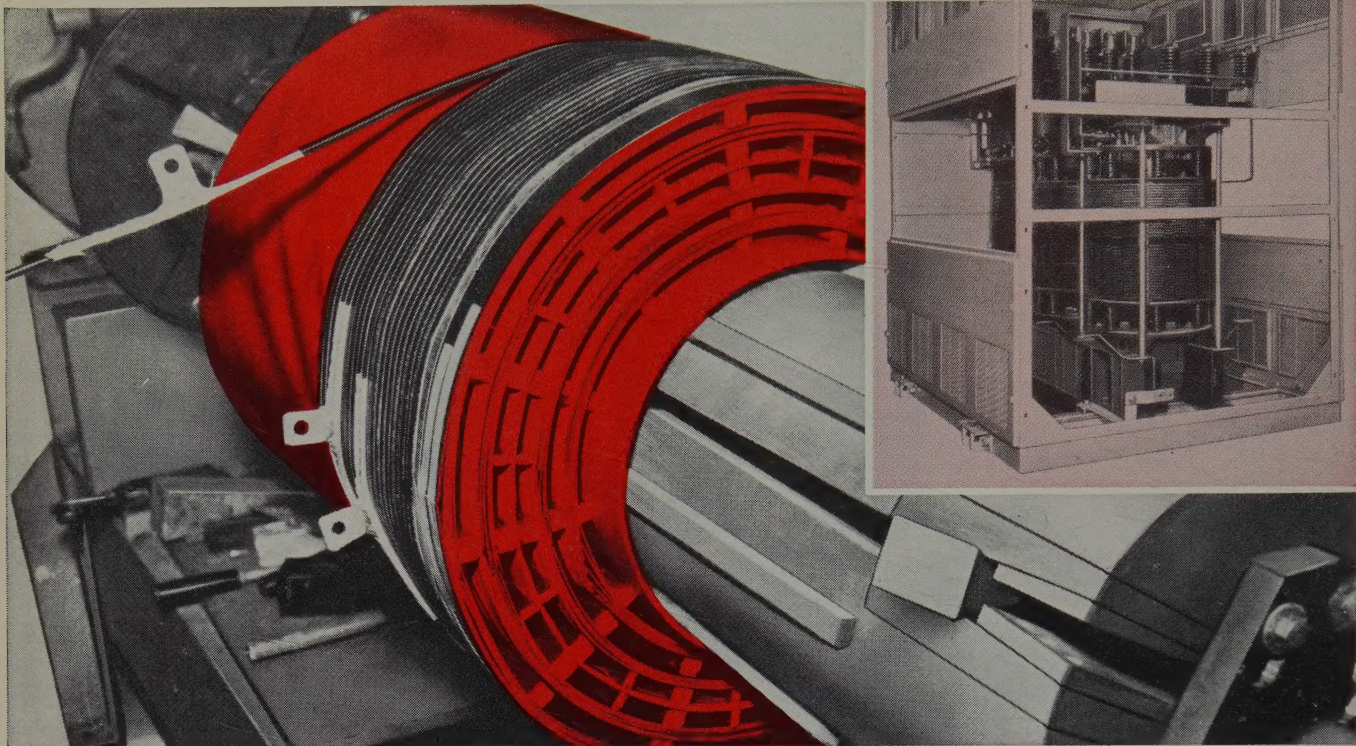
A SUBSIDIARY OF
RAYCHEM
CORPORATION

Now—covers of THERMOFIT especially preformed to fit your component quickly with no positioning problems. A few second application of heat shrinks the cover to tightly encapsulate even the most complex shapes. Available in seven plastic and rubber materials for all environments.

OAKSIDE AT NORTHSIDE • REDWOOD CITY, CALIFORNIA

Print Ins. 4 on Reader Service Card

For Long Service Life



Silicone-Glass Laminates Help Make I-T-E Transformers Reliable, Trouble-Free

Insulating components made from silicone-glass laminates help improve the design and performance of electrical equipment. Bonded with heat-stable Dow Corning silicone resins, glass laminates have high arc resistance, low loss factor, low moisture absorption . . . excellent mechanical and dielectric strength even after prolonged aging at 250 C.

To assure dependable performance of their Class H unit substation transformers, the I-T-E Circuit Breaker Company specifies silicone-glass laminate for spacer strips, the insulating diaphragm between secondary and primary windings, the supporting cylinder, and for interphase barriers.

I-T-E uses this quality construction in ventilated dry-type transformers rated 112½ to 500 KVA; sealed dry-type units rated from 300 to 3000 KVA.

When used with other silicone insulating components, silicone-glass laminates permit smaller, lighter weight transformers that are easier to install and maintain than transformers using any other class of insulation.

Silicone-glass laminates are also widely used for slot wedges, coil dividers, and top sticks in motors; for terminal boards and coil forms in other electrical equipment. Silicone-glass laminates are supplied by leading laminators as tubes, sheets, punched or molded shapes. Write today for full information plus list of fabricators.

PROPERTIES OF SILICONE-GLASS LAMINATE SAMPLES*

Property	Range
Flexural strength, flatwise, psi, Lengthwise	20,000-40,000
Crosswise	18,000-33,000
Izod impact strength, edgewise, ft.-lb./in. notch	
Lengthwise	6.5-17.0
Crosswise	5.5-14.0
Bonding strength, lbs., ½-inch thickness	
Condition A†	650-1100
Condition D-48/50‡	550-950
Water absorption, percent	0.05
Electric strength, volts/mil	
Initial	310
After 200 hr at 260 C	327
After 5000 hr at 260 C	180
Dielectric constant at 10 ² cycles	
Condition A†	3.70
Condition D-24/23‡	3.85
Dissipation Factor at 10 ² cycles	
Condition A†	0.0024
Condition D-24/23‡	0.0084
Arc resistance, seconds	
Condition A†	180-292
Condition D-48/50‡	180-248
Volume Resistivity, meg.-cm.	
Condition C-96/35/90‡	1x10 ¹⁴ -4x10 ¹⁷
Surface resistivity, megohms	
Condition C-96/35/90‡	10-10,000

* As measured on samples ½ inch thick † As received
‡ After immersion in water (hours/deg. C.)
‡ After (hours/deg. C./% relative humidity)

The nearest Dow Corning office is your number one source for information and technical service on silicones.



Dow Corning

Print Ins. 5A on Reader Service Card

... Specify Silicones

Silicones Handle Overloads

Silicone varnish helps make motors safer, more reliable and virtually maintenance-free. These are among the reasons why Automatic Transportation Company, Chicago, uses Dow Corning varnish and a complete silicone insulation system in the drive motors for their line of material handling equipment. These Class H drive motors . . . subjected to inching, frequent starting and reversing, long work cycles, heavy loading when trucks are climbing ramps . . . have more than enough extra capability — assured by the outstanding thermal stability of silicones.

Print Ins. 5B on Reader Service Card

Silicone Rubber Tape Cuts Costs

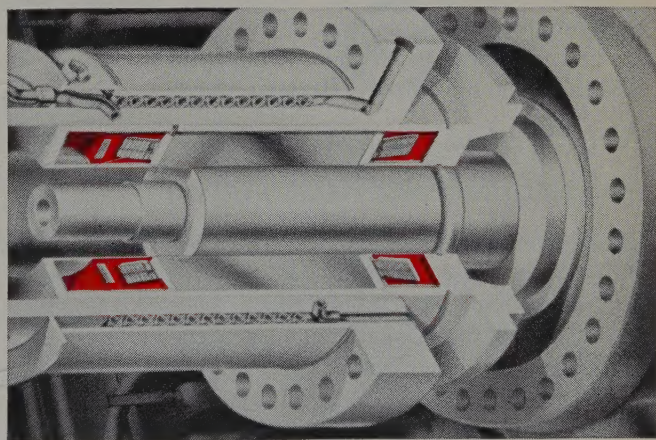
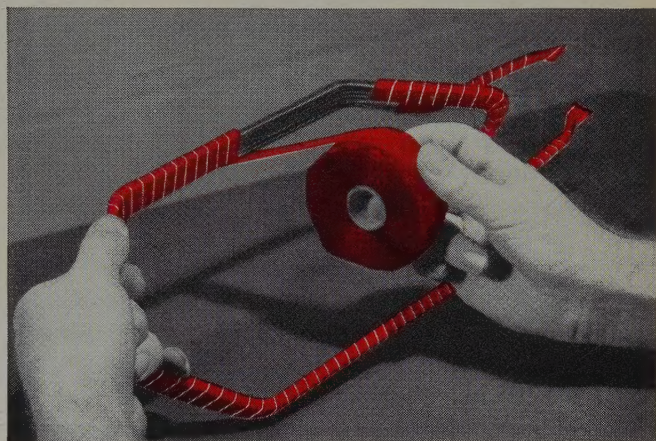
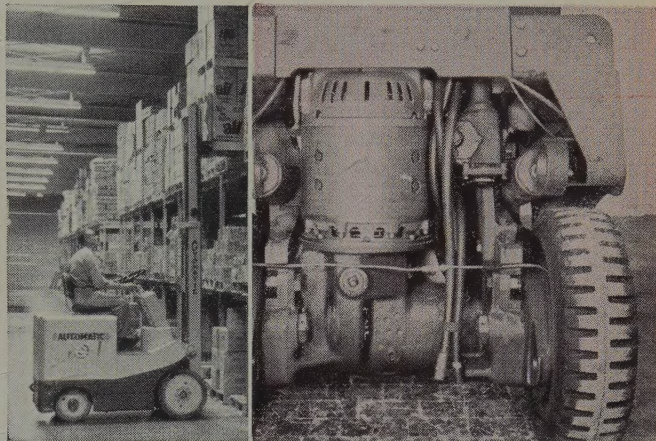
Triangular Guideline tape, made with Silastic®, the Dow Corning silicone rubber, gives you the superior protection of a silicone insulation system while cutting application costs from 50 to 60% compared with conventional taped systems. A single wrap of Guideline tape is all that's needed to produce the entire primary insulation wall thickness. The tape bonds to itself . . . beveled edges overlap to produce a void-free insulation structure . . . conspicuous center line makes it easy to achieve a precise half-lap wrap of uniform thickness. Guideline tape, made of Silastic, produces a homogeneous, resilient insulation system that resists heat, cold, moisture, abrasives, many chemicals and corrosive atmospheres.

Print Ins. 5C on Reader Service Card

Canned Pump Motor End-Turns Potted

Designed for maximum reliability, Westinghouse removable stator canned motor-pumps like this one are used for better boiler circulation in controlled circulation conventional systems. Similar pumps are used to circulate radioactive liquid coolants at temperatures up to 650 F in hermetically sealed primary coolant systems of nuclear reactors. End-turns of stator coils are potted in Dow Corning solventless silicone resins to insure a solid, void-free fill of coil interstices. These solventless resins are radiation resistant, withstand vibration, oxidation, corona and moisture despite continuous service at high temperatures.

Print Ins. 5D on Reader Service Card



CORPORATION MIDLAND, MICHIGAN

branches: ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D.C.

News and Views

Price Reductions

Dow Chemical Co. has reduced prices of phenol one-half cent per pound in all quantity brackets making the new tank car price 17 cents per pound freight allowed. Dow reports the cut was made because of weakness in the phenol price and the inability of many phenol users to fully absorb their increased costs occasioned by the recent advance in the price of phenol.

Food Machinery and Chemical Corp. has substantially reduced prices for volume amounts of "Oxiron" epoxy resins (epoxidized polyolefins) to make them competitive with epichlorohydrin-based epoxies on a quantity basis. In car load lots Oxiron 2002 becomes 60 cents per pound, Oxiron 2001 becomes 80 cents per pound, and Oxiron 2000 becomes 65 cents per pound. Former developmental prices had ranged from \$1.75 to \$2.25.

1962 Electrical Insulation Conference Plans Shape Up

Practically all committees responsible for next Electrical Insulation Conference have been hard at work developing plans and organizing arrangements. The conference is scheduled for February 1962 at the Shoreham Hotel in Washington, D. C. Necessarily, the program committee under the direction of J. S. Hurley, Jr., Silicone Products Department, General Electric Co., Waterford, N. Y., has probably been most active since subjects, authors, and program formats must be arranged well in advance in order to assure selection of the best possible papers. More than 2200, a new record, attended the last conference in Chicago, and it is expected that this figure will be topped by a healthy margin in Washington. The conference includes a technical program, commercial exhibits, and social events. Anyone desiring to present a technical paper at the conference should immediately send an outline of their proposed topic to Mr. Hurley.

New Method for Making Polytetrafluoroethylene Tubing

Continental-Diamond Fibre Corp., Newark, Del., has been granted a patent covering a new method for making polytetrafluoroethylene tubing which reportedly provides a tube having great circumferential strength and the ability to withstand crimping without splitting or cracking. This is said to be a limitation of extruded PTFE tubing. Tubing made by the new process is thus claimed to be useful for forming terminal sleeves for conductors which are crimped to secure them to the terminal leads. The process was invented by Arthur H. Haroldson, John S. Taylor, and William F. Cann, Jr.

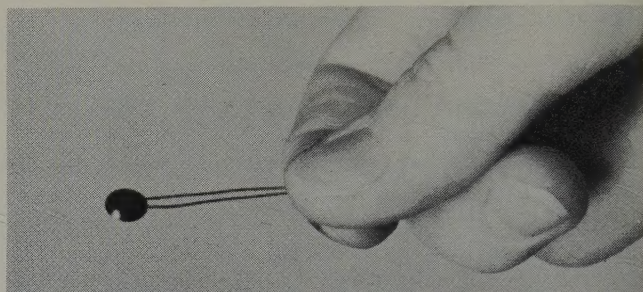
Business Outlook Better

With very few exceptions, nearly all businessmen in

the industry who have been contacted in the last month by *Insulation* editors report improvement in business conditions. The decline is apparently over but the return to higher levels is expected to be very gradual rather than showing a sharp upward spurt. Most leaders look to healthy times ahead but feel that some segments of the economy will be a long time in catching up to past records. The occasional recession is looked upon with favor by some who feel that it helps eliminate deadwood and unprofitable operations.

Silicon Oxide Condensers

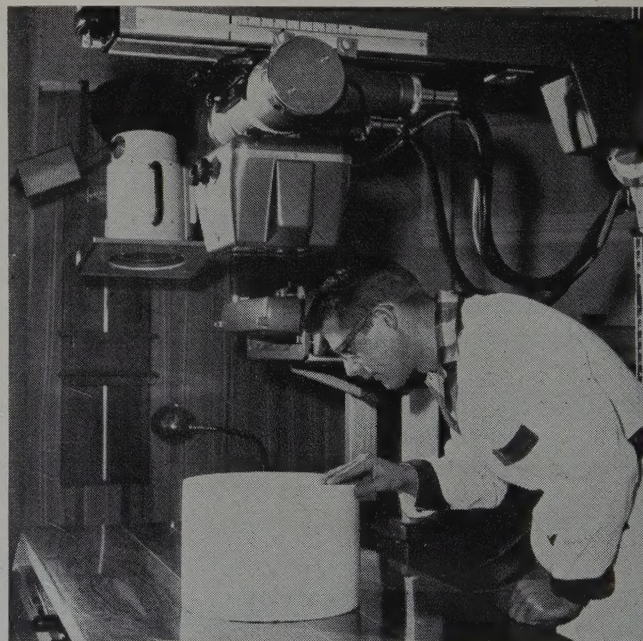
A new type of electric condenser using semiconductor principles has been introduced by Sprague Electric Co., North Adams, Mass. Using silicon oxide as the dielectric,



it reportedly offers extreme stability of capacitance. Features claimed include operating temperature range to 300°F, high insulation resistance, low dissipation factor, and extremely low self-inductance.

X-ray Test for "Teflon" Molding

X-rays are being used by Chemo Products Inc., West Warwick, R.I., in their final quality control "check point" test for Teflon resin moldings. The test determines the absence or presence of flaws within the molding.



ENGLISH ELECTRIC CANADA

USES

NATVAR

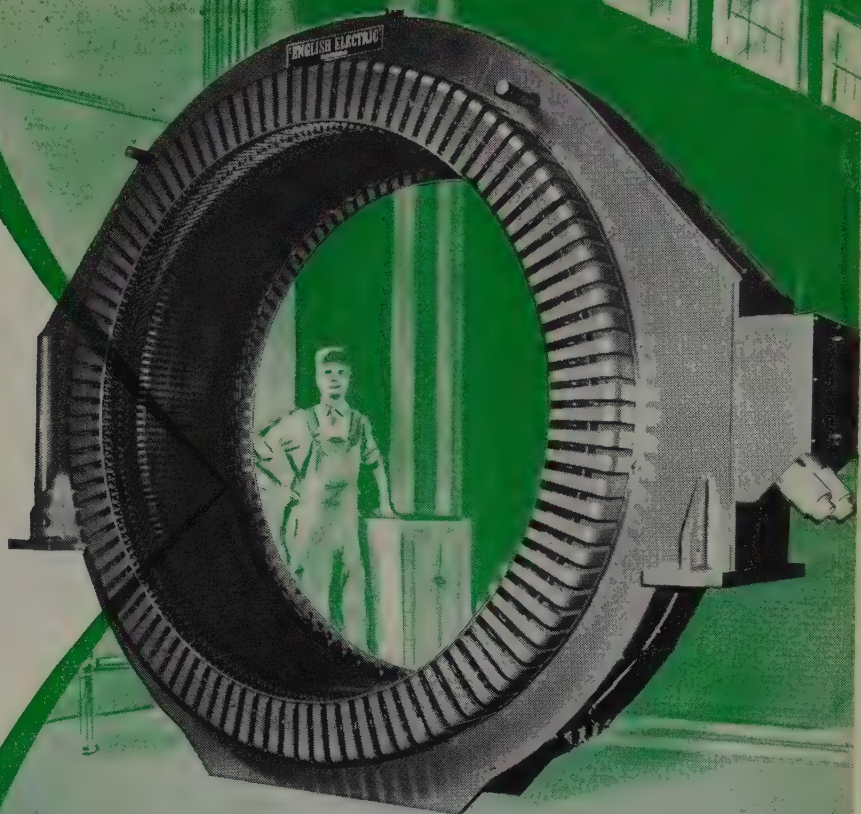
Teraglas®

TO TAPE

STATOR COILS

OF THIS

4500 HP MOTOR



This unit, one of four built by English Electric for export to Europe, is a 4500 HP, 6000 V, 3-phase, 50 cy. synchronous motor stator. Coil ends are taped with Natvar Teraglas, a new flexible insulating material comprising a base fabric woven from polyester (polyethylene terephthalate or "Dacron") warp yarns, and continuous filament glass filler yarns, coated with an improved varnish possessing exceptional dielectric strength under elongation.

English Electric Canada, Toronto, Ontario, Division of John Inglis Co. Ltd. manufacture electrical motors, controls, transformers and switchgear for use in important installations throughout the world.

They have found that Teraglas offers several distinct advantages over the thirsty cotton base tapes formerly used. At no advance in material cost, Teraglas is more readily applied to coils; the higher dielectric strength of Teraglas results in a better insulated coil; and better heat resistance provides a greater safety factor against high operating temperatures due to overloading.

If you are presently using conventional materials, it will pay you to consider the ease of use and extra protection of Teraglas. It is made in four standard thicknesses, .008", .010", .012" and .015", available in sheets, rolls or tapes in black and yellow.

Teraglas® U.S. Pat. Off. (Natvar Corp.)

NATVAR

CORPORATION

FORMERLY THE NATIONAL VARNISHED PRODUCTS CORPORATION

Telephone

TWX

Cable Address

FULTON 8-8800

RAHWAY, N.J., RAH 1134

NATVAR: RAHWAY, N.J.

239 RANDOLPH AVENUE • WOODBRIDGE, NEW JERSEY

Print Ins. 6 on Reader Service Card



Natvar Products

- Varnished cambric—sheet and tape
- Varnished canvas and duck—sheet and tape
- Varnished silk and special rayon—sheet and tape
- Varnished papers—rope and kraft—sheet and tape
- Varnished, silicone varnished and silicone rubber coated Fibreglas*—sheet and tape
- Slot cell combinations, Aboglas®
- Teraglas®
- Isoglas® sheet and tape
- Isolastane® sheet, tape, tubing and sleeving
- Vinyl coated and silicone rubber coated Fibreglas tubing and sleeving
- Extruded vinyl tubing and tape
- Styroflex® flexible polystyrene tape
- Extruded identification markers

*TM (Reg. U.S. Pat. Off.) OCF Corp.

We will be very happy to supply information on any of our products on request.

Insulation Forum

This regular monthly feature is built around a timely question concerning the electrical insulation field. Your suggestion for future questions and participation are invited. This month's question is:

What are your thoughts regarding international standardization of specifications for electrical and electronic insulating materials and what do you think the probable consequences might be?



C. H. Wright

Manager, W. R. Burnett (Pty.) Ltd., Johannesburg, South Africa.

"I am of the opinion that international standardization could be mutually beneficial to every country, and if adopted would have the effect of stimulating reciprocal import/export trade to some extent by removing prejudices, provided no trade restrictions are encountered.

"Standard specifications are generally written to suit the needs of the country of origin, and the terms adopted are those of common usage in that country. International standardization would thus require a code system to be universally practicable—something on the lines of the present classification for thermal stability—to overcome the differing aspects of nomenclature, weights, and measurements.

"Presuming the aim would be for a high standard to prevail, existing standards may of necessity become up-graded or down-graded to strike a common level, so that for internal economic or other reasons some countries may not be willing to readily co-operate in such an innovation.

"In a country such as Southern

Africa where imports are still largely relied upon, my views are naturally influenced by local circumstances. British Standards specifications predominate here, although electrical insulation raw materials enter the country from many parts of the world. It will, therefore, be appreciated that international standardization could have beneficial results by obviating the necessity to assess values of foreign specifications by comparison with locally accepted standards."

R. L. Burns

Manager, Development Div., Australian Electrical Industries Pty. Ltd., Auburn, Australia.

"Human progress seems to move in definite cyclic periods. During the last decade, there has been released a great deal of information on new insulating materials for electrical purposes following intense research work in this subject during the war and immediately afterwards. To complete the cycle (and there has probably never been a greater need than the present) it is necessary to gather together the great mass of information which now exists into the form of standard specifications and in a form which will allow newly appearing materials also to be readily classified.

"Few users have the opportunity to try all available materials in the specific way in which they may apply them. Standardization of specifications should lead to some degree of rationalization, enabling the alternatives to be identified as such and highlighting true differences—the value of which to the user can then be more easily assessed and more correctly applied. Such a service must lead to advances in the art of manufacture and more satisfactory products wherever they may be used. Less obvious, but nevertheless as real, it should lead to a more effective use of past research work on the subject and provide better directivity for similar work in the future."



D. E. Kissel

Operations Research Analyst, Technical Operations Inc., Burlington, Mass.

"I think the problem of international standardization of specifications is deserving of a detailed analysis. The analysis could probably best be done by a group of representatives from the standardization agencies of the major industrial countries of the world. We would have to depend on such a group for specific recommendations. At this time, all I can offer are some general ideas concerning the need and value of such standardization.

"Every country in the world which produces a significant amount of electrical and electronic equipment has an agency which establishes specifications on insulation materials. In the United States, a private agency, the National Electrical Manufacturers Association, provides standard grade specifications for all electrical equipment and materials. In most all other countries the specifications are established by a bureau of the national government (the British Standard Institute in England, for example).

"At the present time, there does not appear to be any formal attempt to bring together these various agencies and to get them to standardize on a single set of specifications. Some of the larger American companies, however, with overseas manufacturing subsidiaries or sales organizations make comparisons between the various standards systems for their own purposes.

"Such comparisons, unfortunately are not all-inclusive and are not readily available to the entire industry.

"It may be too much to hope that a single standard of specification could be produced in the near future. As a first step, there is merit in categorizing in a parallel fashion the various specifications of the major industrial nations. This would be a "dictionary" for translating between

A Remarkable Development in High Quality Tape!

VARSIL SR 1050

**SUPER HIGH-STRENGTH BONDING
SEMI-CURED SILICONE RUBBER TAPE**

FOR
MOTOR COILS • CABLES
FLEXIBLE HOT AIR
TUBING

**HIGH
MECHANICAL
STRENGTH**

**HIGH
DIELECTRIC
STRENGTH**

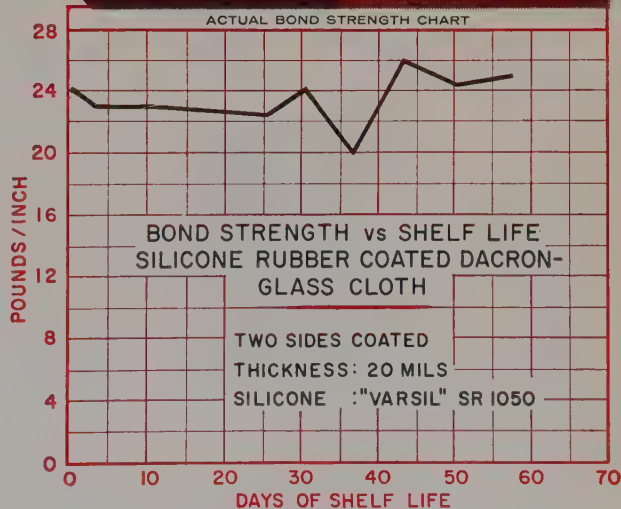
**HIGH
BONDING
STRENGTH**

Excellent Power Factor

There's nothing better than NJW's *new* VARSIL SR1050 for rugged Class H applications! It's the best bonding tape of silicone rubber on glass cloth... The exceptionally tight bond and good flow of rubber means no voids — maximum dielectric strength.

ALSO AVAILABLE — VARSIL SR1050 on Dacron-glass combination cloth, with just the necessary stretch for excellent conformity (keeping volts-per-mil-high). Unusual flow of rubber during vulcanization eliminates voids and assures good bonding strength. Outstanding shelf life too, (see chart). Try it for that special job which demands the highest quality tape.

■ Available single or double faced. ■ Agents in principal cities.
■ Complete test data free samples available, on request.



NEW JERSEY WOOD FINISHING COMPANY

MANUFACTURERS OF FLEXIBLE ELECTRICAL INSULATION • WOODBRIDGE, N. J.

VARNISHED CAMBRIC CLOTH AND TAPES • VARNISHED "FIBERGLAS"† CLOTH AND TAPES • VARNISHED SILK AND SILK SUBSTITUTE • SYNTHETIC RESINOUS TAPES AND EXTRUDED TUBING • POLYETHYLENE, SHEETS, TAPES AND EXTRUDED TUBING • CABLE WRAPPING TAPES • "VARSIL" SILICONE VARNISHED "FIBERGLAS"† CLOTH AND TAPES • "VARSLIT" COMBINATION SLOT INSULATION:—RAG PAPER AND VARTEX VARNISHED CAMBRIC • FISH PAPER AND VARTEX VARNISHED CAMBRIC • RAG PAPER AND "MYLAR"* POLYESTER FILM • ASBESTOS PAPER AND "MYLAR"* POLYESTER FILM • KRAFT PAPER AND "MYLAR"* POLYESTER FILM • VARTEX VARNISHED "FIBERGLAS"† AND "MYLAR"* POLYESTER FILM • SPECIAL COMBINATIONS AVAILABLE UPON REQUEST

*Mylar, DuPont's registered trademark

†Fiberglas, Owens-Corning Fiberglas registered trademark

Print Ins. 7 on Reader Service Card

the various national standard systems. The present incompatibility of specifications is part of the language barrier inhibiting freer trade.

"Formulators in the Boston area have expressed the feeling that a readily available conversion catalogue would create interest in the promotion of foreign sales and would facilitate bidding on foreign contracts. They realize, of course, that any such easing of trade restrictions works both ways. It now becomes easier for people overseas to enter the American market. On the whole, however, they believe that such intrusion would be small compared to the gains which the more diverse American producers and formulators could make."

W. E. Anderson

President, Universal Insulations Co., Ltd., Aurora, Ontario, Canada.

"International standardization of specifications for electrical and electronic insulation materials would give many advantages to manufacturer and user alike in price reductions and design. However, from our experience with all types of insulation which we manufacture, it would be necessary to standardize at the design level and we doubt that this will ever become a reality. We hesitate to forecast the effect of this possible international standardization on our own electrical industry for import or export trade, as we believe labor costs of production would influence this phase of the market."



Robert T. Todd

Manager, Electrical Products Div., Minnesota Mining & Manufacturing of Canada Ltd., London, Canada.

"The international standardization of specifications on electrical and electronic insulation materials would, undoubtedly, bring many benefits. For example, standardization almost always results in lower costs and consequently broadened markets for the product itself, or the items into which

the product is incorporated.

"In both our domestic markets and our export markets our competitive position might well improve with standardization of international specifications on insulation materials. North American technology has many times proven itself capable of being competitive with costs in even comparatively low wage countries (on like items), and there is no real reason why this cannot be so with insulation materials.

"There would seem to be only one real hazard in establishing international specifications on insulation materials. With such rapid advancement taking place, provision would have to be made for ready modification of specifications to fully utilize the benefits of these advances. Such flexibility is, of course, necessary with any specifications group."

P. J. F. Cooper

Executive Director, Langley London Ltd., Crawley, Sussex, England.

"The more the manufacture of electrical insulating materials becomes a specialist industry, the more important it is that industry speaks with one voice.

"The International Standards Organization is the body which already exists to co-ordinate national specifications into international specifications, and the electrical insulation industry should co-operate to the fullest extent.

"A wide variety of insulating materials does not lead to economy or efficiency in production. An international specification cannot only raise the general standard of quality but also, because of the greater volume of production offered to manufacturers by world standardization, lower price levels should be possible.

"Too frequently we, in the United Kingdom, are asked to quote to American NEMA, German DIN, or other national specifications which invariably differ in some degree from our own British Standards. To quote and supply means non-standard production at an increased price or, alternatively, asking the customer to accept a British Standard with which he is not conversant. The same applies in

reverse with other countries wishing to supply to the United Kingdom.

"Complete international standardization would open each country to competition from the supplies from every other country, with all the advantages to the electrical industry which free enterprise competition brings.

"New materials and products would be available freely in all countries and international trade would expand with increasing prosperity for all."

Richard Kithil

Vice President, The Carwin Co., North Haven, Conn.

"I can only comment that I feel eventual standardization or technical equality is inevitable in any competitive economy, due to natural forces dictated by business necessity. The same forces see to it that prices inevitably seek a common level in a competitive economy. I feel that one of the most argumentative subjects of the present decade is whether or not a competitive economy should be maintained across national borders. The administrations of the last two decades worked for this. At the outset of the '60's, our balance of trade dilemma and economy at home made the matter questionable. On matters formerly protective trade barriers scarcely exist today. Should they be renewed?"

R. A. Robertson

Chemical Engineer, Sangamo Co. Ltd., Toronto, Canada.

"Canadian industry in general uses United States standards or standards based on them. I presume the question refers to standardization of American and European specifications. This standardization if completed (it will be difficult as American companies themselves use different specifications) would eliminate problems of comparing materials tested under different conditions from various countries. Marketing in foreign countries would be considered more attractive. Canada in particular would experience more imports. Trade with the United States, in my opinion, would increase—but on a fairly even export-import ratio.

MOISTURE

HEAT

OVERLOAD



FORMVAR based wire enamels... best for Class B systems, too!

That's right... now you can extend your use of FORMVAR based wire enamel to Class B systems. The method is simple. Simply overcoat FORMVAR based wire enamel with one of the newer commercially available impregnating varnishes. The combination offers increased thermal stability of the entire system—and you get all of the proved advantages of FORMVAR. Excellent windability, high overload resistance, and resistance to heat, moisture, cut-through and abrasion.

This technique to upgrade thermal stability has been proved in use. Shawinigan has always been first with new developments, new applications and technical assistance for the wire industry. Twenty years background in producing poly-

vinyl formal resin—the basic ingredient in *all* FORMVAR wire enamel—assures you of the best in products, the best in service. For more information on the easiest, most dependable combination of commercial varnish overcoat and FORMVAR based wire enamel, write Shawinigan Resins Corporation, Springfield 1, Massachusetts.

SALES OFFICES: ATLANTA, CHICAGO, LOS ANGELES, NEW YORK, SPRINGFIELD, CLEVELAND, SAN FRANCISCO, GREENSBORO, ST. LOUIS.
IN ENGLAND AND EUROPE: SHAWINIGAN LTD., MARLOW HOUSE, LLOYD'S AVENUE, LONDON E.C. 3.

FORMVAR® polyvinyl formal by



Print Ins. 8 on Reader Service Card

"The most significant advantage of this standardization would be the benefits derived by the insulation user. Work done in foreign countries would not require interpreting or sometimes duplicating. Thus a paper presented in any country would be of value to all without further work."



E. R. Pfaff

Chief, Electromagnetic and Nuclear Physics Branch, Admiral Corp., Chicago.

"When one considers the problem of international standardization of specifications for electronic insulation materials, it seems that the economic aspects outweigh the technical considerations. I am therefore confining my statements to this area. Our government is greatly concerned at this time about the flow of gold out of the country due, in part, to the unbalance between the import and export of materials and manufactured products. There is little that can be done about cheap labor competition (except increased import duties) from countries having a standard of living that is lower than ours, but we can do something about the quality of imported merchandise that we are buying. The creation of international specifications for electrical and electronic materials will help to assure that the quality of imported goods is at least equal to our domestic production. It is my opinion that we are now doubly handicapped by the lack of standards and the cheap labor problem. For example, an instance that recently came to my attention concerned an imported product that was otherwise satisfactory, but which would not pass underwriters' tests because the coil forms were flammable and the insulation was otherwise unsatisfactory.

"The existence of adequate standards should be helpful in both the export and import markets by creating a basis of comparison between

competitive products as far as insulation materials are concerned."



J. Szogyen

Chief Rotating Machine Engineer, English Electric Canada, A Division of John Inglis Co. Ltd., Toronto, Ontario, Canada.

"International standardization in the electrical field is under the auspices of the International Electrotechnical Commission (IEC). Some 35 countries hold membership in the IEC. There are more than 50 Technical Committees in the IEC, the ones dealing with insulation being:

TC — 2C Classification of Insulating Materials

TC — 10 Insulating Oils

TC — 15 Insulating Materials (has 11 working groups)

TC — 28 Insulation Co-ordination

TC — 36 Insulators

"One publication dealing with insulating materials was issued by IEC in the years 1959 and 1960. This is: Publication No. 112, *Recommended Method for Determining the Comparative Tracking Index of Solid Insulation Materials Under Moist Conditions*.

"Four draft publications dealing with insulating materials are now being circulated, or were circulated in the years 1959-60 for approval: 1) Draft Test Procedure for the Evaluation of the Thermal Endurance of Enamelled Wire. 2) Draft Recommended Methods of Test for Electric Strength of Electrical Insulating Materials at Commercial Power Frequencies. 3) Draft Guide for the Preparation of Test Procedures for Evaluating the Thermal Endurance of Electrical Insulating Materials. 4) Draft Standard Methods of Test for the Determination of the Insulation Resistance of Solid Insulating Materials.

"Work is in progress on such subjects as test conditions for insulation

resistance measurements, test cells for measuring resistivity of insulating liquids, measurement of dielectric constant, standard temperature—life charts, hygroscopic and mechanical properties, and effects of radiation.

"These highlights of the international standardizing activity will show how extensive this work is. I think it will result in establishing a set of terms of reference that will, in time, be used more or less universally. This in time will lead to better co-ordination of national standards. The benefits to be obtained from this work are betterment of understanding between electrical engineers, and as a result, development of international trade."

Alden F. MacDonald

Fellow Engineer, Materials & Process Engineering, TV-Radio Division, Westinghouse Electric Corp., Metuchen, N.J.

"I think there should be an international standardization of specifications for insulation materials. I understand that the committees of the International Electrotechnical Commission are working toward this end.

"If standards were in use it would reduce the cost of goods manufactured for export. In some countries more costly materials must be used to meet local requirements. This is usually due to lack of experience rather than need for safety or longer life of apparatus. Therefore, more types of equipment must be made and stocked to meet all the requirements of foreign countries. If one type complying with an international standard could be manufactured for export, it could be made at a lower cost and in larger quantities.

"Imported equipment, not made to a common standard, usually cannot be sold in all areas. If made to meet our requirements, it would be more expensive in some cases. A common standard would remove one source of difference between our products and imports; closing the gap between cheap labor on one side, automation and ingenuity on the other."

K. E. Simonsen

Chemist, Research Laboratory,

Thomas B. Thrige, Odense, Denmark.

"While one can certainly agree that the attainment of international specifications for insulation materials is a most desirable goal, there is no doubt that difficult work lies ahead requiring rather a long time before a satisfactory result is reached.

"However, international organizations, for example the IEC, including the USA organizations, are carrying out a very intensive work in preparing testing methods for insulation materials. International approval of such methods appears to progress satisfactorily, and as this is the primary basic condition for international specifications, a good step in the right direction has already been taken.

"Even if some users' own specifications are to be standing, and even if development, fortunately, still continues in this field, it should be possible to lay down more and more international instead of national specifications. In our opinion, this development will result in fewer variants in materials and thereby an ultimate reduction in costs. Furthermore, the user will have better possibilities for a constant optimal utilization of the space destined for insulation materials in machines and apparatus.

"Finally, we would say that the progressing standardization of specifications will be of immense value for international trade, the greatest remaining obstacle being the different systems of weights and measures still existing."



Hans Kallas

Dipl.-Ing., Burghausen Obb., Germany

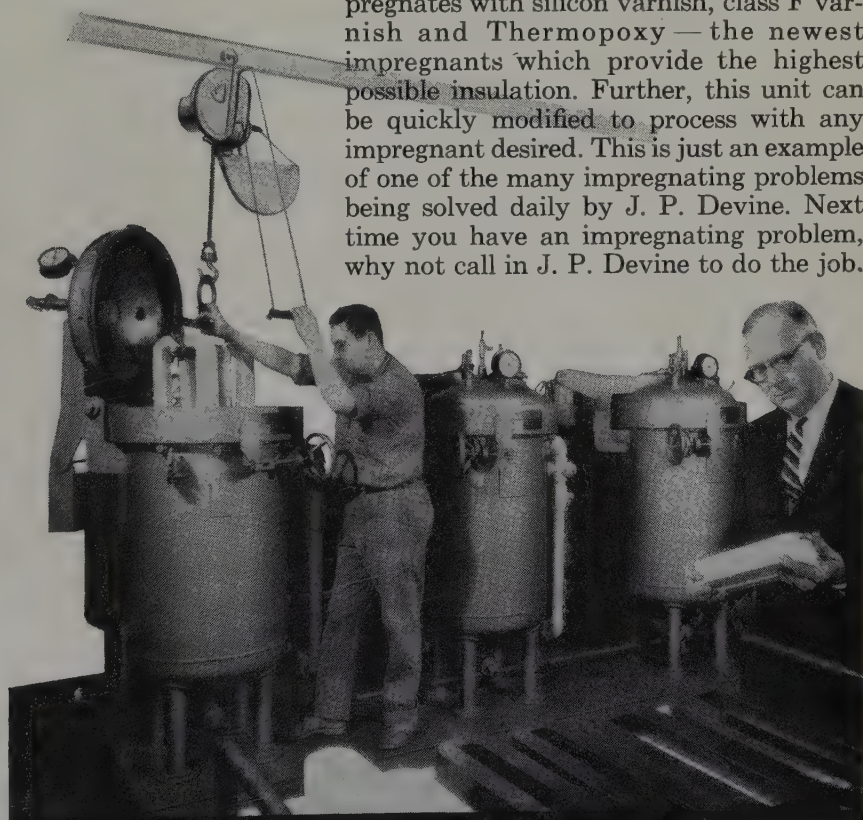
"To a small extent, international standardization of specifications and temperature classifications has taken place for generally accepted insulation materials. The next step should be the standardization of the most im-

VACUUM IMPREGNATING

with
**Flexibility,
Minimum
Plant
Floor Space**

Devine Model 709 is a unique new unit created to meet the needs of independent coil manufacturers. It offers vacuum impregnating, adaptability to any impregnant—all on a compact space-saving platform. The unit has three vacuum and pressure vessels lined with stainless steel, and each of these has its own vacuum-storage tank. The system operates at 200 microns, and the three-phase system operates from a single high-vacuum pump.

Shown examining coils in production at the Stimple & Ward plant is Mr. Andrew Knorr, the company's president. Mr. Knorr selected the new Devine unit because it combined so many fine engineering features and satisfied his company's requirements. J. P. Devine Model 709 consecutively impregnates with silicon varnish, class F varnish and Thermopoxy—the newest impregnants which provide the highest possible insulation. Further, this unit can be quickly modified to process with any impregnant desired. This is just an example of one of the many impregnating problems being solved daily by J. P. Devine. Next time you have an impregnating problem, why not call in J. P. Devine to do the job.



J. P. DEVINE MFG. CO.

**A UNIT OF
COX
INDUSTRIES**

49TH STREET & A.V.R.R. • PITTSBURGH, PA.

New York Office: 500 Fifth Ave., New York 36, N.Y. Phone: Wisconsin 7-7769

Export Office: 50 Church St., New York 7, N.Y. Cable Address: "Brosites"

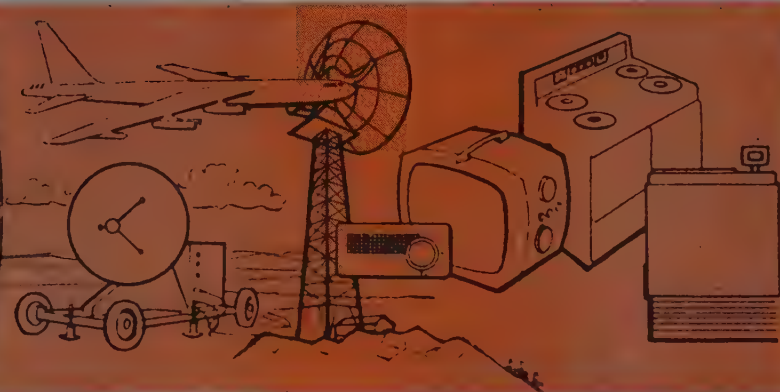
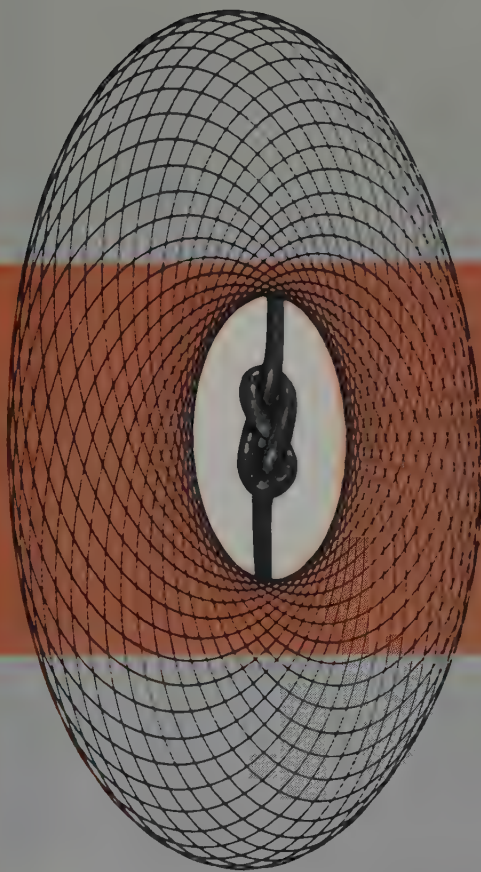
Print Ins. 9 on Reader Service Card

BRAND-REX TURBO[®] INSULATING SLEEVINGS

Circle the entire range of
Tubular Dielectrics

To solve insulation problems or to spark new ideas . . . Brand-Rex Turbo sleeves run the spectrum of insulating materials . . . from extruded polyvinyl chloride and teflon tubing to a complete line of cotton, rayon, and glass braids coated with vinyl, silicone, silicone rubber or alkyd varnishes. A complete range of sizes in classes A, B, F and H. Both tubing and zipper tubing configurations available.

Important, too, is the reliability built into Turbo products. Reliability based on the experience of 40 years and the capability of a technically-oriented organization with three plants located from coast to coast, all backed by the vast resources of the American Enka Corporation. It makes sense to call Brand-Rex!



This comprehensive brochure and sample board give complete technical information. Write for yours today.



WILLIAM BRAND-REX DIVISION

American ENKA Corporation

DEPT. T, 36 SUDBURY ROAD, CONCORD, MASSACHUSETTS
Vinyl, Teflon, Polyethylene, Nylon and Silicone Rubber Wires and Cables
Electrical Tubing and Sleeving — UHF Cast Plastics — Plastic Extrusions

Print Ins. 10 on Reader Service Card

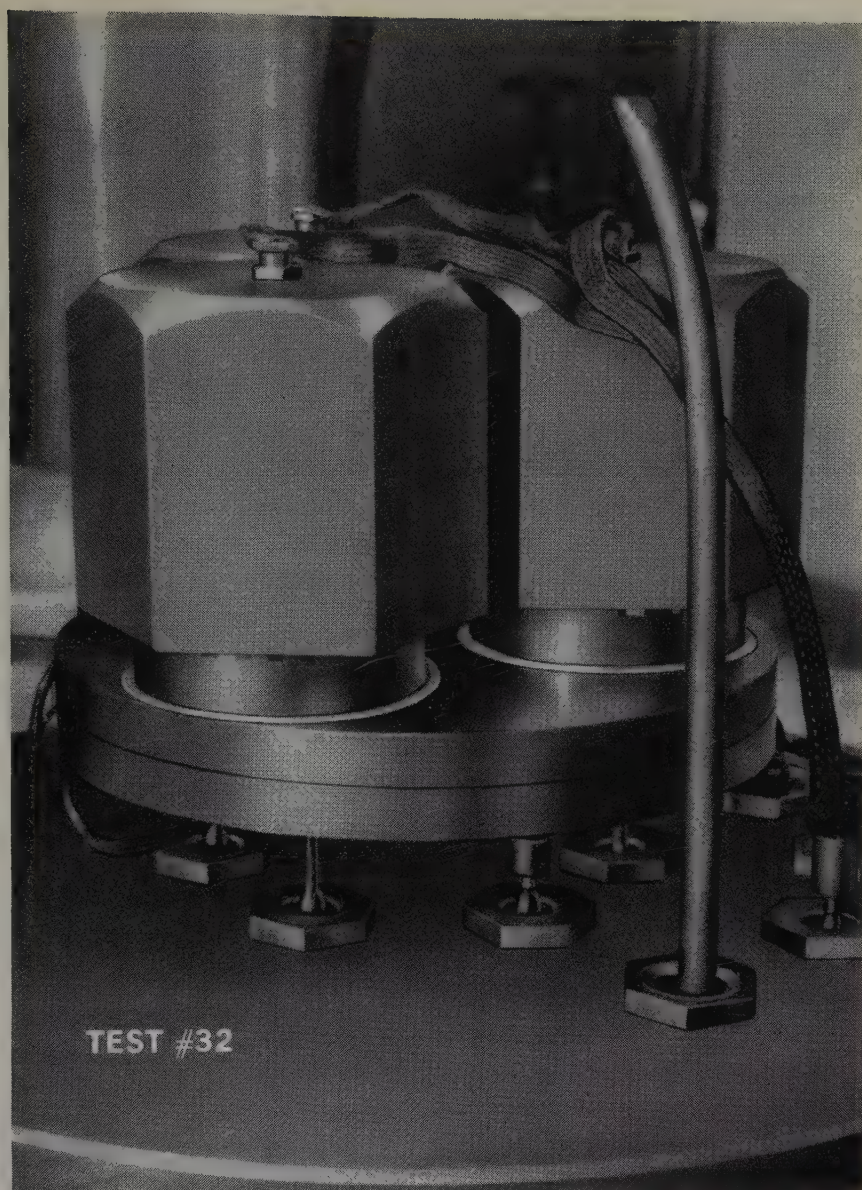
portant insulation materials. However, I don't think that it is possible to grade insulation materials or insulation materials groups of the same or similar chemical compositions. Standardization should be limited to insulation systems that have been proved under conditions of practical applications.

"Extensive work covering such test methods has been done in the USA and is being continued. Therefore, it should not be too difficult to find universal standard testing methods for testing insulation materials systems. It would follow that if we were able to use standard insulation systems, it should also be possible to build and use electrical equipment on a similar basis of standards. But in this area especially, the differences between various countries are great indeed!

"It seems that the problem of standardization of electrical insulation materials cannot be separated from standardization of the whole electrical manufacturing industry. The necessary steps for a corresponding cooperation in international committees should be coordinated as follows: 1) Devising test methods and absolute minimum values for testing the life of insulation systems. In addition, it will be necessary to place synthetic and natural insulation materials into separate classes. However, care should be taken that this does not hinder the rapid development of the synthetic materials.

2) The great differences in standardization of electrical equipment existing at present should be reduced. We can be certain that eventually this, together with standardization of temperature limits for insulation classes would result in the same theoretical life of insulated parts in similar electrical applications.

3) In many cases, the construction of the equipment is responsible for creating thermal and mechanical stresses in the insulation under actual operation. All these factors make it difficult to specify insulation materials needed for specific applications, while universal standardization would simplify the matter considerably and increase trade between countries and continents."



44 Tests Show This Capacitor Tissue's Best

Shown here is our Dry Power Factor Test. Flat samples of paper are vacuum dried under the three electrodes above, and then measured for 60 cycle power factor at temperatures from 125 degrees C. down to 40 degrees C.

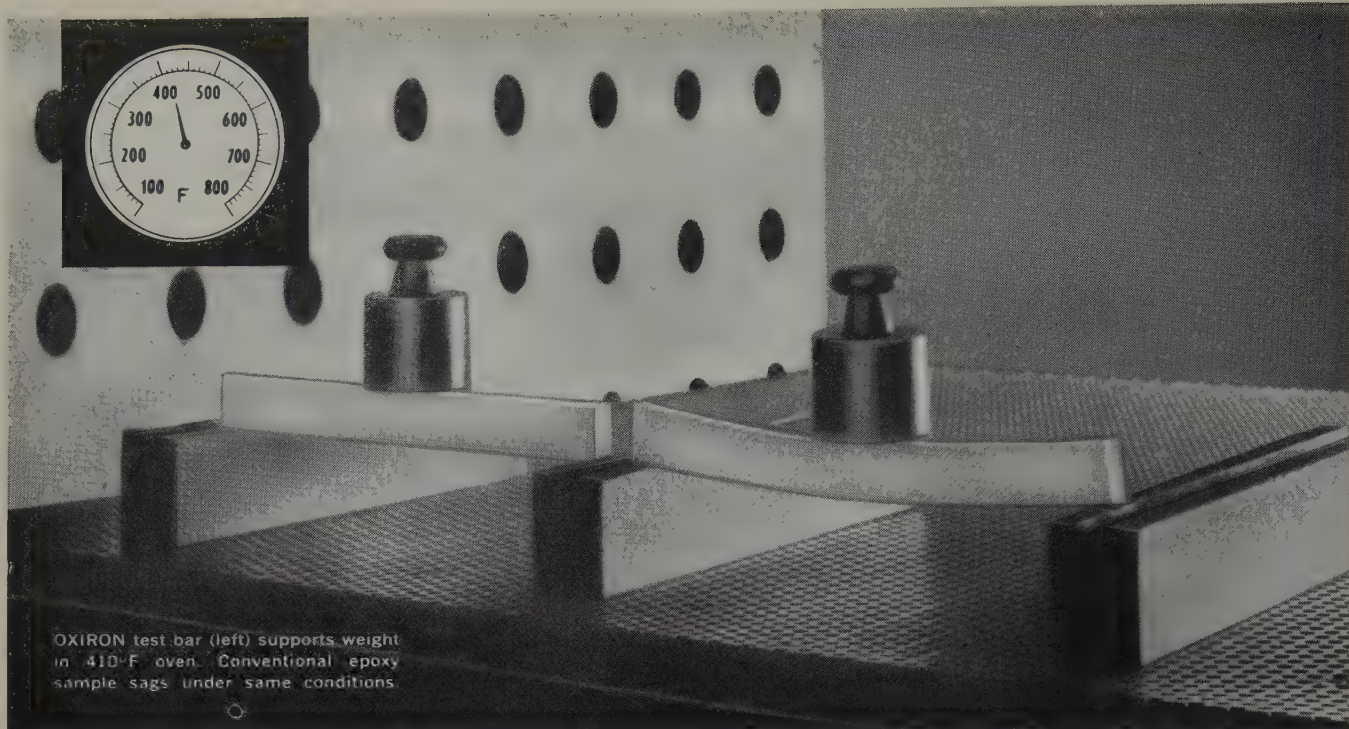
This is just one of 44 different kinds of tests (and literally thousands of measurements) given to every lot of CBP Capacitor Tissues.

Is it any wonder CBP Capacitor Tissues are called the *most-tested* tissues in the world? You can be certain your specs will be met at Crocker, Burbank.

CBP Capacitor Tissues are available in a wide range of grades from low to high density, with uniformly high purity and low power factor.

**CROCKER,
BURBANK
PAPERS Inc.**
FITCHBURG, MASS.

CAPACITOR TISSUE • CABLE INSULATION • MAJOR INSULATION • SATURATING KRAFT
Print Ins. 11 on Reader Service Card



OXIRON test bar (left) supports weight in 410°F oven. Conventional epoxy sample sags under same conditions.

NEW OXIRON EPOXY RESINS OFFER UNUSUAL HIGH TEMPERATURE PROPERTIES

Even after long exposure at elevated temperatures, OXIRON resins have high flex strength and show little weight loss. Anhydride-peroxide-cured OXIRONs resist deformation over a broad range of temperatures. The gentle rise of their heat distortion curves demonstrates why these resins are acceptable for practical use at temperatures far above the heat distortion point (see diagram). In addition to high-temperature strength, OXIRONs have excellent electrical properties which they retain over a wide range of temperatures; show superior resistance to creep at elevated temperatures.

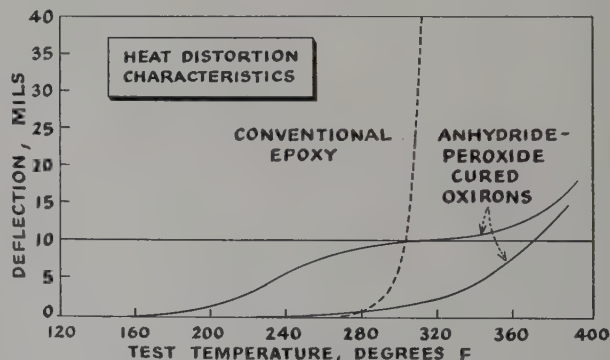
OXIRON resins are unique as epoxies, because they are epoxidized polyolefins rather than bisphenol-epichlorohydrin-type reaction products. Since they provide 10 or more reaction sites per "monomer" unit, they have a remarkable degree of chemical versatility, as their cure reactions show. The resins are available in a wide range of viscosities and offer an unusual combination of advantages:

Novel Cure: OXIRONs can be cured through their reactive double bonds as well as epoxy and hydroxyl groups. They are the only epoxy resins that can be cured with peroxides. However, conventional epoxy curing agents may also be used. OXIRONs have high reactivity with anhydrides and dibasic acids at low temperatures . . . provide increased pot life with polyamines . . . react with a variety of other curing agents such as polyphenols, Lewis-type catalysts, polysulfides.

Economy: Low-cost curing agents may be used in high proportions.

Low Density: 20% lighter than ordinary epoxies—cured resins likewise have lower density.

Outstanding Chemical and Electrical Resistance: Excellent resistance to alkalis, acids and solvents—cured resins have good electrical properties.



This graph shows that—unlike conventional epoxy resins—the heat distortion curve of OXIRONs does not break sharply with temperatures . . . can be used above the heat distortion point itself.

Send for our *Epoxy Data Booklet* which describes OXIRON 2000, 2001, and 2002 in detail, contains curing information and gives suggested uses. If you'd like a sample, let us know what application you have in mind so that we can supply a suitable resin.



FOOD MACHINERY
AND CHEMICAL
CORPORATION

Epoxy Department

161 East 42nd Street, New York 17, N. Y.

EPOXIDES CURRENTLY AVAILABLE FROM FMC

OLEFIN OXIDES

Octylene Oxide • Dodecene Oxide • C16-C18 Olefin Oxide

TERPENE OXIDES

Limonene Monoxide • alpha-Pinene Oxide

DIEPOXIDES

Dicyclopentadiene Dioxide • Limonene Dioxide

Print Ins. 12 on Reader Service Card

New Developments in Epoxy Resins

Part 6—Wide Range of Handling and End-Use Properties Now Available

By Dr. Henry Lee, Technical Director, and Kris Neville, Project Engineer, The Epoxylite Corp., South El Monte, Cal.

The range of handling properties and the range of end use properties which can be formulated into epoxy compounds has increased markedly since the appearance of these new resins on the American scene 10 years ago. While early resins and curing agents gave a limited range of gel or setting times and a limited range of use temperatures, growth of the epoxy resin technology has rapidly pushed back limitations to the point where versatility has become a byword.

This article surveys typical electrical grade epoxy compounds and their applications to indicate the modifications possible to achieve the specified handling and end-use properties. The chief points stressed are (1) viscosity control and handling method at time of application, (2) gel time and temperature, and (3) cured properties as influenced by the processing requirements.

VISCOSITY CONTROL AND HANDLING METHODS

Often the required cured properties will impose restrictions upon handling convenience. Sufficient viscosity control cannot be obtained by changes in the formulation.

For example, suppose that it is necessary to encapsulate a very high-voltage transformer. Corona considerations, in addition to dictating the materials of construction, also make necessary the attainment of a completely void-free, low-stress casting. Following is a typical specification designed to obtain this objective:

Transformer Design: Transformer must be designed according to sound electrical principles, limiting layer-to-layer voltages by limiting coil length.

Insulation System: Magnet Wire—Compatible with the impregnant. Layer-to-Layer Insulation—Use one layer unimpregnated fused polyester mat sheeting. Do not use polyester fiber/film sandwiches. Do not use

polyester fiber tape or impregnated polyester mats. The mat should be pulled snug, but not stretched.

Primary-to-Secondary Insulation—Use two layers of polyester mat sheeting.

Nut and Bolt Insulation—Fillet nuts and bolts with a paste epoxy formulated for electrical insulating qualities and to relieve thermal crack stress points.

Impregnation and Encapsulation—Select impregnation system in terms of viscosity, thermal shock resistance, and thermal stability.

Processing Technique—

1. Warm transformer and mold to 180°F.
2. Warm epoxy to 180°F. Mix thoroughly for 5 minutes.
3. Transfer epoxy compound to mold in vacuum tank, making sure tank has adequate reservoir.
4. Pull a vacuum of 1-3 mm mercury for 5 minutes. Release to atmosphere. (Use nitrogen if available.)
5. Pull a vacuum of 1-3 mm mercury for 10 minutes. Release to atmosphere. (Use nitrogen if available.)
6. Repeat step 5. (Subsequent pressurization to 100 psi with nitrogen is desirable if available.)
7. Remove transformer and mold.
8. Gel overnight (15-16 hrs) at 140°F. (Avoid the stresses of higher gel temperatures.)
9. Cure 24 hrs at 200°F. (Avoid curing stresses of higher cure temperatures.)

Using this specification, together with properly formulated epoxies, high voltage transformers have been produced which withstand proof tests at 1200-1500 pulses at 150,000 volts.

Less detailed and time consuming procedures are, fortunately, the usual case, and often modifications of the formulation may be made to accommodate handling considerations, principally in respect to the viscosity of the system. A variety of methods are

available to control system viscosity, both to lower it and to increase it.

Reduced Viscosity

Monofunctional diluents or low viscosity resins may be employed to achieve viscosity reduction. Solvents may be used in applications where they can be driven off prior to or during cure. Low viscosity curing agents may be selected. Heat may be used when the pot life and/or exotherm characteristics permit.

As a general rule, monofunctional diluents and solvents are avoided insofar as they tend somewhat to decrease cured properties in terms of chemical resistance and thermal stability and to increase the system potential for skin irritation. They also reduce the compatibility of the resin with magnet wire.

Increased Viscosity

Often it is as important to increase system viscosity as to reduce it. When increased viscosity is desirable, it may be obtained through the use of higher viscosity resins or curing agents (when weight is critical) or through the use of fillers. In the selection of suitable fillers, the lesser amount is preferred to the greater amount when a flexible or semi-rigid cured structure is involved; the reverse is true when the cured structure is rigid. Flow characteristics can be closely controlled by the selection of the proper filler or fillers together with the proper particle size or sizes. When higher loading volumes are employed, blends of fillers are normally preferred to prevent settling during cure or storage.

Variations Possible

Because of the variety of alternatives available, electrical-grade formulations can be developed which are, at working temperatures, almost as thin as water; or which provide non-

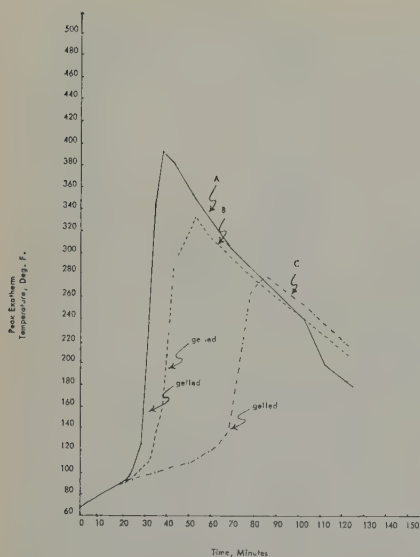


Figure 1, progressive modification of the curing agent increases pot-life and reduces exotherm. In a one-pound casting, pot-life can be more than doubled with very little effect upon final cured properties of the system.

sag characteristics in rather thick masses to temperatures as high as 250°F; or which brush-on to give a controlled build-up of from a few mils up to 50 mils or so; or which possess substantial initial "holding tack."

GEL TIME AND TEMPERATURE

Long pot lives and fast gel times are desirable production goals; but they are more or less contradictory. One cannot (at least at the present state of the art) have an indefinite room temperature pot life with a fast, room temperature cure.

Generally, the short pot life problem can be overcome for high production by the use of continuous processing equipment; while, for low production, the use of small batch mixing may be tolerated.

Heat can be used to accelerate cure, so that rapid recycling of molds and reusable equipment can be achieved; or cold may be used to retard cure when it can be conveniently provided.

Long Pot Life Curing Agents

Long pot life systems can be obtained by the use of anhydride curing agents, by the use of blocked amines, and by the use of Lewis-acid complexes and other materials as de-

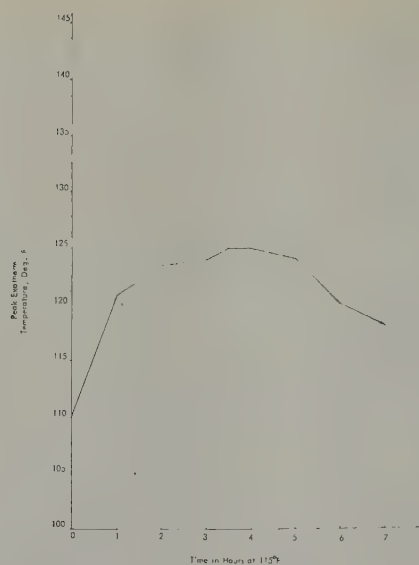


Figure 2, low-exotherm casting resin is necessary for the potting of temperature-sensitive elements. Using a cure of 115°F, the exothermic rise in 2/3-lb. casting is limited to about 10°F over cure temperature.

scribed in part 2. When these systems require intolerably long cure times, accelerators may be employed at some reduction of pot life. Tertiary amine accelerators are preferred for acidic curing agents; and acids, such as phenol, are normally preferred with the basic curing agents.

Fast Curing Systems

Fast curing systems may be obtained from unblocked Lewis acids and primary aliphatic amines; cures ranging from a few minutes to overnight at room temperature are practical. In some cases, the amount of curing agent may be varied (within limits) to produce slight increases or decreases in the cure time.

Control of Pot Life and Cure

To the extent that the curing agent influences cured properties, the user is limited in selection; but within a given range of acceptable properties, it is usually possible to vary pot life and cure time, at least to some degree, to accommodate production requirements.

CURED PROPERTIES AS INFLUENCED BY PROCESSING REQUIREMENTS

Use of Ovens

Perhaps the single most important production—and quality control—re-

quirement for handling the epoxy resins is adequate oven capacity. Whenever heat curing is possible, and ovens are available, the user is permitted to choose from all the various possible formulations. When heat curing is not possible, or when upper temperatures are limited by the component to below 200°F, the number of potential formulations is sharply reduced.

In addition, heat curing (for short periods of time) almost inevitably improves the performance of the room-temperature-curing materials and leads to more reproducible results, since to some degree at least, it can be used to compensate for minor errors in proportioning. Use of elevated temperatures also eliminates the effect of variations in the working ambient temperatures, which can vary within a given plant over a given period of time as much as 40 or 50°F. The temperature dependence of the reaction rate and the effect of temperature on handling properties has been indicated in previous sections.

Most electrical components will tolerate cure temperatures to at least 275°F (the standard varnish-curing temperatures) and few epoxy formulations, except for some very specialized high-temperature adhesives and laminating resins, require higher temperatures than this. To the extent that a unit can be designed to permit a cure cycle of 4-16 hours at 275°F, from the standpoint of the epoxy formulation such a cycle is virtually ideal, although the 225-250°F range is usually acceptable.

Temperature Sensitive Components Impose Severe Limitations

Many electronic components, however, have limited heat resistance, and should not be exposed to temperatures in excess of about 180°F. Since, in a substantial mass, most room temperature curing agents generate exothermic temperatures in excess of this, and most low-exothermic heat-curing systems require higher temperatures for cure within a reasonable time, the formulation can become rather sophisticated. The general procedure is to accelerate—or to attempt to accelerate—low exotherm curing agents and to minimize the amount of resin re-

quired, either through mold design or by the use of fillers.

When room temperature cures are required—or when fast, low-temperature cures are necessary (a heat lamp or a hot air gun is all that can be applied, for example)—not a great deal of sophistication is possible. Appropriate formulations (with one or two notable exceptions) will be deficient in heat resistance; and in all cases, the attainment of thermal shock resistance (to the ubiquitous -65°F of the military specifications) will be difficult. Careful design of the components involved, together with attention to necessary reinforcements, will be required. On some units, unfortunately, even this won't help.

Use of Vacuum Equipment

As indicated earlier in this discussion, vacuum equipment may be necessary. In the vast majority of electronic and electrical applications, however, this is not the case.

Vacuum and vacuum/pressure is necessary when the wire sizes are very small or where the *complete* elimination of voids or even microscopic air bubbles is essential (usually because of the corona problem), or where relatively viscous systems must be processed to obtain the necessary cured properties.

In many cases, however, vacuum is used because the formulation selected requires it; and by changing the formulation and/or processing temperatures, vacuum processing can be eliminated and a substantial over-all saving in costs can be achieved.

One reason for the prevalence of vacuum processing is that it leads to an apparent saving on epoxy insofar as it permits use of a rather highly-filled resin system. Such systems have a lower per-pound price. However, often the economy is illusory. The addition of fillers leads to a proportionate increase in specific gravity. The less expensive filled system just doesn't go as far; and the weight of the completed unit is proportionately increased . . . resulting in higher shipping charges on industrial items and less payload in missiles and aircraft. These considerations, combined with the elimination of the time-consuming

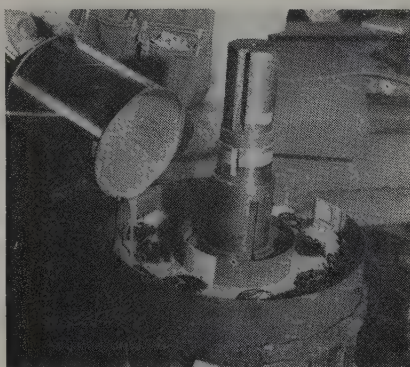
vacuum operation, will dictate the selection of the most fluid resin available capable of fulfilling the end-use requirement. As indicated in foregoing sections, the introduction of new resins and the development of more ingenious formulations makes possible new, cost-saving approaches to present production problems.

APPLICATIONS IN THE ELECTRICAL-ELECTRONICS INDUSTRY

The preceding general remarks are related to the accompanying illustrations by means of the captions.

We have tried to indicate applications illustrating the versatility of the epoxies; and of course, direct attention to specific applications which seem inherently of interest, and which may suggest still others to the reader.

Room Temperature Curing Liquid Epoxies

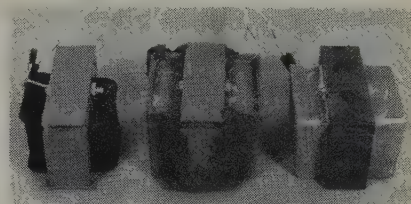


A low-viscosity, room-temperature-curing liquid is used for sealing motor coil against "Freon" 22. Compound is satisfactory for class B electrical duty but requires reinforcement to pass thermal shock. Standard thermal-shock-resistant systems are deficient in resistance to Freons.

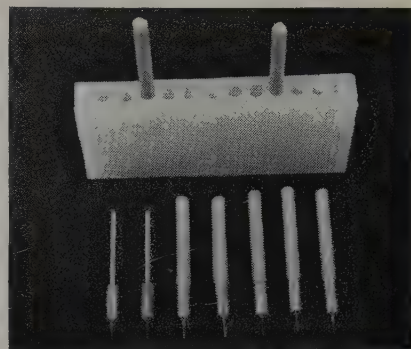


Low-viscosity, high filled system is used as a rigid connector potting compound. High filler loading volume is used to increase rigidity and dimensional stability. Filler loading volume is approximately 60% with a room

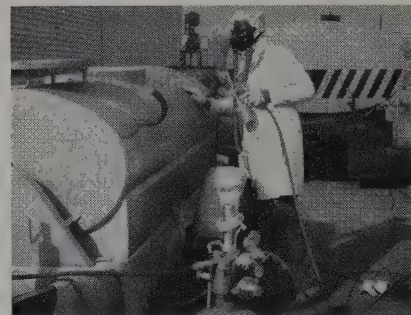
temperature viscosity of 11,000 cps and a specific gravity of 1.736.



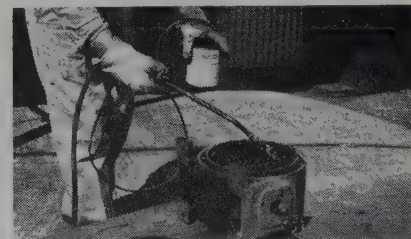
Low-viscosity system is used to impregnate small coils. Vacuum is eliminated and low-irritation-potential curing agent is employed. Thermal shock resistance is not critical in this application and fast cure is desirable.



Low-viscosity system is used to insulate electrode-contact pins. Low exotherm in this mass permits use of expendable, drilled wax molds.



Low-viscosity, solvent-containing system is used as tank liner. Rust in water would increase electrical conductivity and increase hazard involved in washing-down hot, high-voltage bushings. Higher buildup system is used.

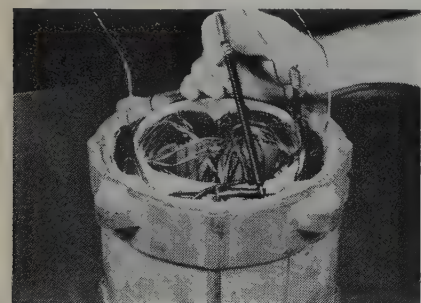


Spray-on protection for motor windings.



Low-viscosity system is used to make 5 kv potheadless termination on paper-lead cable. System is selected for adhesion to lead and contains reinforcing fillers to improve arc resistance. Room-temperature cure is essential to permit field use. This application also illustrates interesting use of acrylic fiber tape. Acrylic tape is used instead of glass to reduce tendency to wick-in moisture and to provide increased wetability.

Room-Temperature Curing, Controlled Flow Epoxies



Brushable, 100% solids system is used to saturate and seal insulating canvas around motor frame to prevent contact of frame with windings.

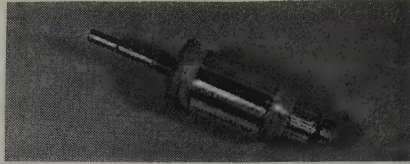


Use of brush-on system for protecting coil too large for available oven. Glass reinforcement is employed to improve thermal shock resistance.



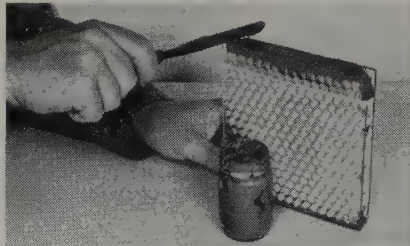
Brushable epoxy system is used to bond wooden spacers to separators for oil-cooled transformer. Operation

eliminates drilling and doweling. Compound sets in 30 minutes at room temperature, serves to 300°F in transformer oil.



Brush-on system is used to coat windings of small armature. Use of brush-on material eliminates need for molds.

Room-Temperature Curing Heavy, Non-Flowing Epoxies

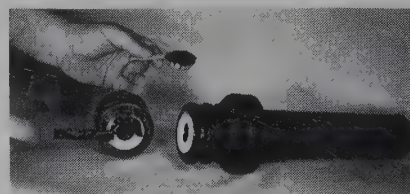


Use of liquid epoxy highly filled with copper powder to achieve electrical conductivity. Bonds to "Plexiglas" and aluminum honeycomb of radar dome. Copper powder provides sufficient electrical conductivity to drain high voltage away from high capacitance of honeycomb and thereby protect personnel.

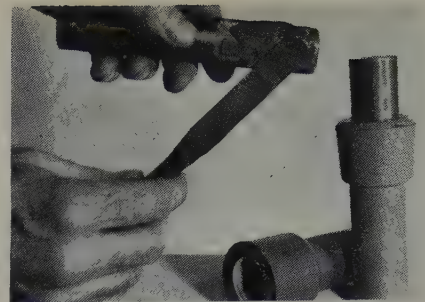


Paste system which provides for room-temperature cure in approximately 30 seconds after application (pot-life about 60 seconds) is here used to provide seal against flowing leak.

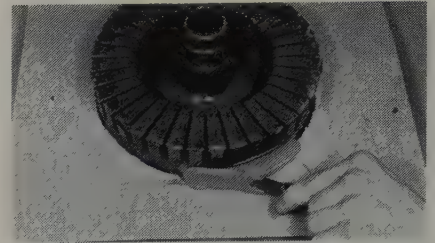
Miscellaneous applications for a room-temperature curing, non-flowing paste:



repair bushings



bond brush-holder studs



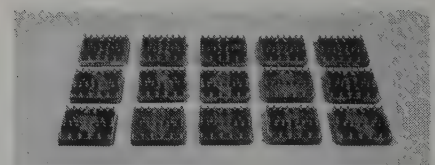
bonding insulation to pancake motor



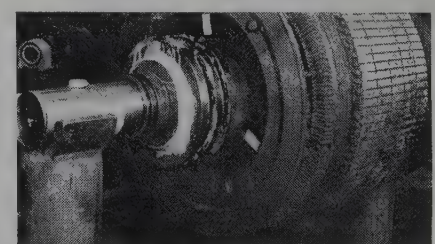
repairing arc chute or switchboard



blocking form-coils to replace tie-strings

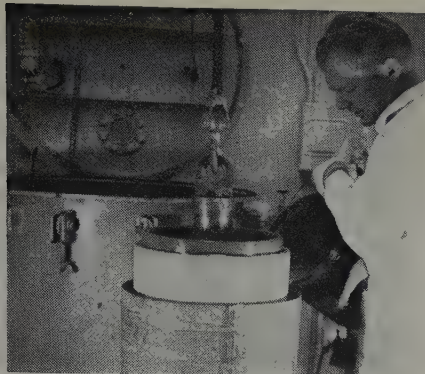


bonding gold-flashed terminals in epoxy laminate

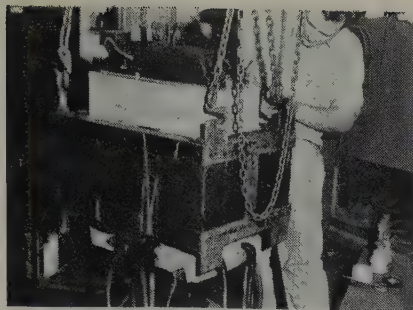


repairing slip-ring assembly.

Long Potlife, Heat Curing Epoxies



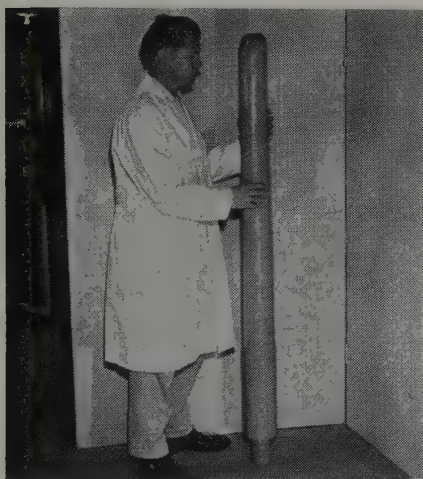
Low-viscosity, long-pot life system is used for vacuum-impregnation of specially-wound 500 hp traction armatures. After impregnation, armature is drained and baked. Units so treated have given million-mile service on railroad equipment.



Low-viscosity thermal-shock-resistant system is suitable for making castings as large as 200 lbs at one pour with hundreds of pounds of metal inserts.



Brushable system is used on glass wire to provide high strength rotating field coils. Flexural deformation temperature over 300°F, with upper service temperature of 350°F.



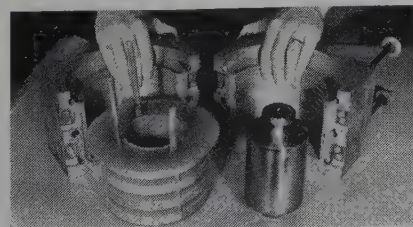
Liquid system is used for the impregnation of glass-wrapped oil well probes serving in environments where top ambients may reach 450°F.



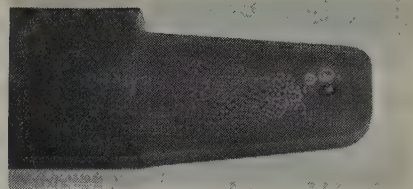
Epoxy system is brushed on strap wound induction-furnace transformer. Pot life in excess of 8 hours facilitates production.



Potting compound for magnetic chucks and lifting magnets is poured into hot chuck, following which heated pea gravel or 16 mesh sand is added to the extent possible to replace more expensive epoxy.



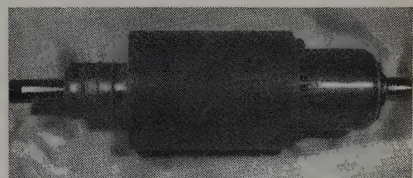
Use of heat resistant epoxy filled with silica for potting connector rings.



Low-viscosity heat curing system provides excellent fill in motor windings without the need for vacuum impregnation. Compound is especially designed for motor repair shop operations.



Use of high-temperature epoxy (long time service at 500°F) as insulation for special motor studs. Material is applied to glass cloth with spatula until sufficient build-up is obtained, and cured structure is then machined.



Use of high-temperature epoxy for encapsulation of missile armature. This unit operates in ICBM at peak temperatures well in excess of class H. Careful attention was required to obtain reinforcement to permit unit to be cycled to -65°F.

EPOXY SERIES REPRINTS AVAILABLE

Several firms are considering reprinting this complete series of six epoxy articles which started in the December 1960 issue and is concluded in this issue. One firm is definitely reprinting the series—see "New Literature" feature (No. Ins. 301) to obtain single copies at no charge as soon as they are printed.

How to Punch Vulcanized Fibre to Reduce Fabrication Costs

by K. H. Alverson, Product Standards Director

Vulcanized Fibre's capacity for easy punching makes this material highly attractive to the designer whose application calls for characteristics such as good dielectric strength, light weight, rugged strength, irregular contours and holes and indentations in the surface of a part.

Punching is done with two kinds of precision: Rough punching uses the lowest cost solid dies, is rapid and economical, but leaves a fractured raw edge and is limited to stock thicknesses through $\frac{1}{4}$ in.; smooth shaving uses a contour die ground to a sharp edge that slopes away at 45° . The edge shaves stock when the part is forced into the die producing smooth edges in parts up to 1 in. thick. Holes can be punched easily, but should be generally spaced from each other and from any edge by at least the thickness of the stock. Non-circular holes and counterbores should be made circular for machining when the stock thickness specified is too thick to punch.

For thickness under $\frac{3}{64}$ ", vulcanized fibre can be punched most economically with steel rule dies. Dies for simple parts usually cost much less than solid dies even for irregular contours. Tooling for scoring or creasing can also be added with little additional cost.

Most parts can be punched without additional conditioning if the vulcanized fibre has its normal moisture content of $5\frac{1}{2}$ to 7%. For especially difficult punchings, or for parts thicker than $\frac{1}{8}$ ", heating up to 200°F may be desirable.

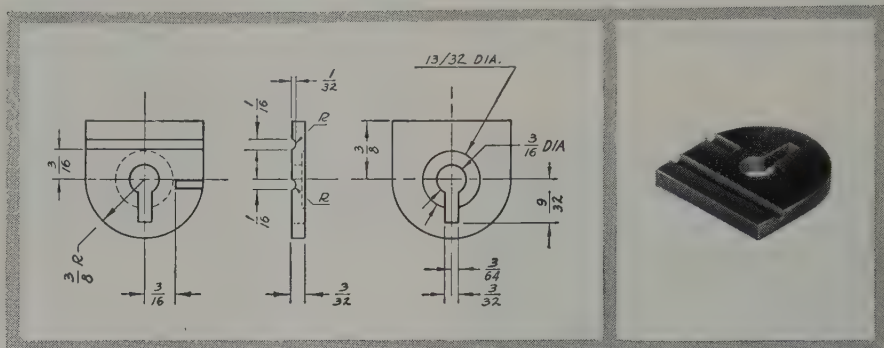
Additional economies may be obtained in thicknesses $\frac{1}{16}$ " and under by using coils slit from parent rolls, reducing waste of stock, speeding up the punching operation, and reducing inspection costs.

Many extras may be incorporated in punching operations on vulcanized fibre. These include scoring or creasing for subsequent forming along established lines. Also practical are swaging or forming into special shapes, such as shoulder bushings or angles.

Stamping letters and numerals into

the surface of vulcanized fibre in the punch-press operation produces permanently legible markings with no increase in cost of the part. White or colored roll leaf characters can also be impressed into the surface to give color contrast at very little added cost. Punched parts are also readily printed with rubber stamp.

Spaulding Engineers who have been trained in Value Analysis can help you take advantage of the wide range of possibilities in designing to reduce costs through the use of vulcanized fibre parts. They also make available to you Spaulding's extensive fabricating facilities and experience in working with this extraordinary material.



The fabrication of this shut-off switch insulator demonstrates vulcanized fibre's facility for punching and swaging. Previously moulded out of nylon, the part is now made

by swaging both sides and punching vulcanized fibre—all in the same operation and at lower costs both for material and processing.

Send for your FREE copies of this literature



Value Analysis Brochure —
case histories of design improvement and cost reductions that have been accomplished through Spaulding's value analysis of customer products.

Vulcanized Fibre Engineering Data —
a design reference book which comprehensively covers all the application specs of vulcanized fibre.



SPAULDING FIBRE COMPANY, INC.

314 Wheeler Street • Tonawanda, New York

See our Display at the Design Engineering Show, Booth 939

Print Ins. 13 on Reader Service Card

Degradation of Polymers By External Corona Discharge

By R. F. Grossman, *Anaconda Wire & Cable Co., Marion, Ind.* Information in this article was presented orally at the Ninth Annual Communication Wire and Cable Symposium, Asbury Park, N. J.

Corona, the ionization of gas (usually air), induced by a voltage gradient, and leading to a discharge current of ionized particles, is known to damage dielectric materials on which it impinges. In the case of many useful polymers, this damage is apt to be severe, and results in the rapid deterioration of the polymer's dielectric properties. If the polymer is in service as electrical insulation, sustained corona discharge eventually produces direct failure. The mechanism of this action is incompletely understood. It has been variously ascribed to ionic bombardment, electron bombardment, ozone attack, and localized heating. Two observations, the fact that corona discharge in air is known to generate ozone, and that corona attack of elastomers produces surface cracking, have given rise to the belief, common to the rubber and plastics industry, that ozone attack is the sole factor involved. It will be shown that this hypothesis alone cannot account for all of the experimental observations.

Several recent studies^{1,2} have concluded that bombardment of the dielectric by ions or electrons, produced in the ionization of air, and accelerated by the applied field, may be the primary factor in corona degradation of some polymers. One of these is particularly illuminating. In a series of experiments, Crabtree has shown that natural rubber samples, when stretched and subjected to corona discharge in inert, non-oxygen containing gases, suffer cracking similar to that caused by ozone.³ This is a clear-

cut case of degradation caused by a particle bombardment phenomenon.

The recent work of C. D. Nail⁴ has shown that at least one polymer, polyethylene, is attacked far more rapidly by corona discharge from a negative than a positive electrode. This observation, taken with arguments concerning the relative energies of electrons versus ions, suggests strongly that electron bombardment is more probable than ionic bombardment, and that electron bombardment is the chief factor involved in the degradation of polyethylene. We have been able to confirm these conclusions⁵ by correlating the area exhibiting corona damage in polyethylene sheets with the theoretical range of electrons produced by corona discharge in air. This was done by comparing the radius of oxidized polyethylene on a polyethylene sheet that had been in contact with a spherical electrode producing corona, with the maximum possible radius of electrons generated in the discharge (see figure 1). The agreement between the area of damage expected from electron bombardment and that experimentally observed is quite good. The degradation of *polyethylene* by corona discharge may, therefore, be ascribed chiefly to reactions initiated by electron bombardment.

Electron bombardment during corona may be viewed as a special case of radiation damage, proceeding through the initiation of free radical reactions within the polymer, producing chain scission and cross-linking, and leading to crack formation at points of strain. It should be empha-

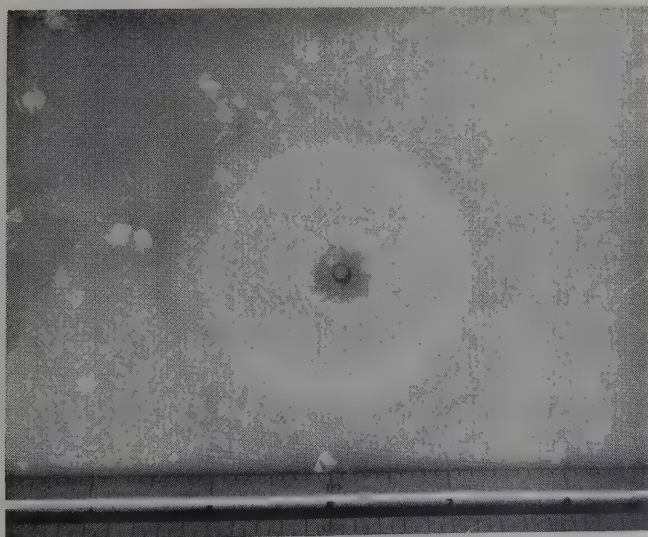


Figure 1.

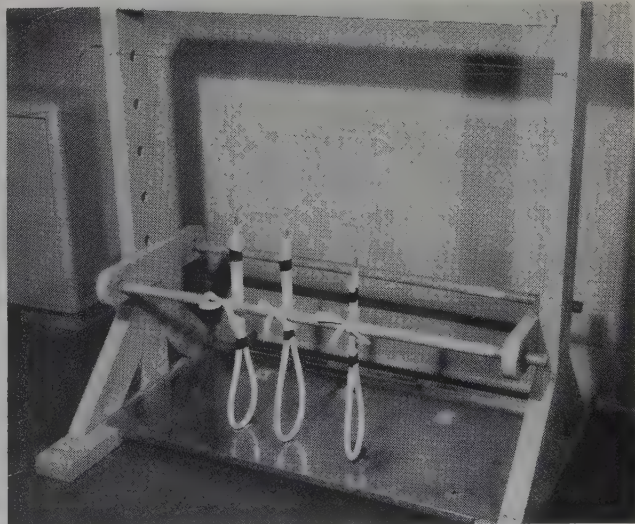


Figure 2.

sized that any reaction leading to decreased elongation of the polymer will eventually produce cracking at points of strain, regardless of whether the means of initiation of the reaction stems from ozone attack or a bombardment phenomenon. It is the purpose of the present study to relate the processes of ozone attack and electron bombardment to the failure of various rubbers and plastics under corona.

In order to approximate the physical conditions under which electrical cables may be damaged by corona, data was gathered using the well-known vertical "U"-bend test on completed cable samples. This consists of bending a sample length of cable to a specified diameter "U", then mounting that "U" perpendicular and tangent to a grounded metal plate (see figure 2). An a-c voltage, sufficient to achieve a specified average voltage gradient across the cable insulation, is applied between the conductor and the metal plate. The time to dielectric rupture is the measured quantity.

Data was obtained at 25 kilovolts applied voltage to 5 X diameter "U" bends of 5 kv unshielded cable consisting of 10/64 butyl insulation over 6 strand tinned copper construction, jacketed with 4/64 of various materials. These were:

- A) Low density polyethylene
- B) High density linear polyethylene
- C) Polyvinyl chloride
- D) "Hypalon"
- E) A typical butyl jacket compound

- F) A butyl jacket compounded for optimum ozone resistance
- G) A typical neoprene jacket compound
- H) A neoprene jacket compounded for optimum ozone resistance

The ozone resistance, expressed as the time required for visible cracking to appear, at 0.03% ozone, by volume, at room temperature, of these materials is presented in figure 3. In a parallel graph, the time to corona failure under the conditions described above is presented in figure 4.

Some caution must be exercised in attempting to compare diverse materials, since the intensity of the corona discharge is related to, among other things, the dielectric properties of the jacket. Nevertheless, certain broad deductions are justifiable. One is that polymers bearing residual unsaturation are apt to be highly variable in both ozone and corona resistance. The polymers, primarily neoprene and butyl rubber, do, however, exhibit improved corona resistance when compounded for optimum ozone resistance. It therefore follows that ozone attack must play a prominent part in the corona failure of cable jacketed with neoprene or butyl rubber. Compounding variables had relatively little effect upon the corona or ozone resistance of fully saturated polymers, such as polyethylene or polyvinyl chloride.

With fully saturated materials, having outstanding ozone resistance, there is no correlation of ozone and corona resistance—these two problems are entirely sepa-

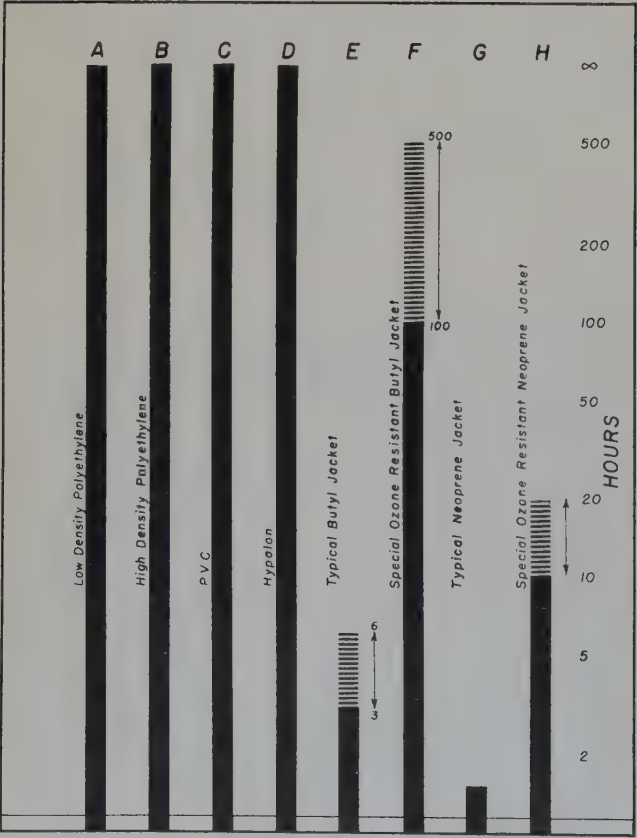


Figure 3, ozone resistance at 0.03% ozone concentration.

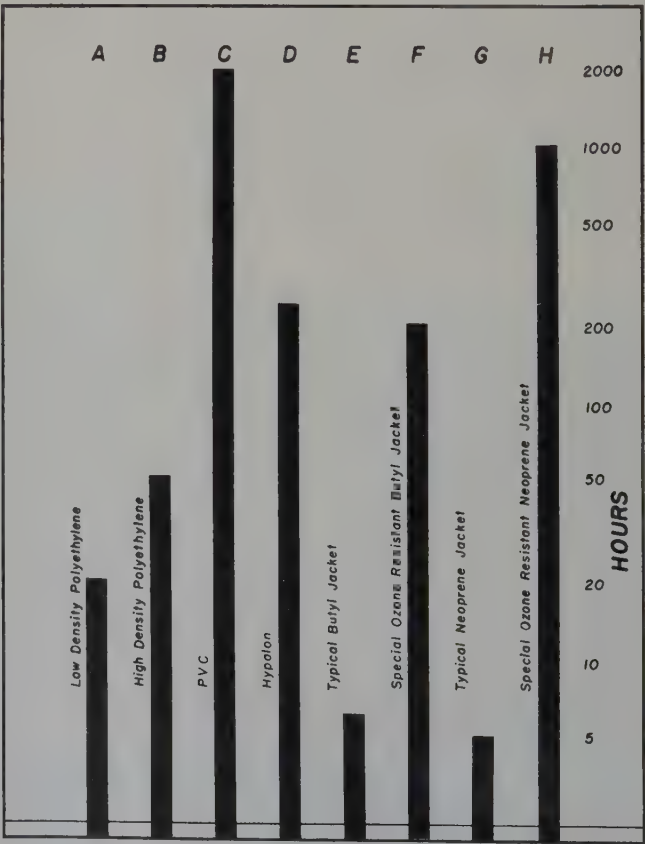


Figure 4, corona life at 25 kv.

rate and distinct. With materials containing residual unsaturation, ozone and corona resistance are related but not identical.

In figure 5 resistance to corona damage versus applied voltage is plotted for high and low density polyethylene, and typical, although not especially ozone resistant, butyl and neoprene compounds. Two types of curves are obtained, one falling smoothly with rising voltage, in the case of polyethylene, and one falling with extreme abruptness, in the cases of the rubber samples. This difference results from the dissimilarity of the mechanisms involved in the attack of the saturated polymer, polyethylene, and the unsaturated polymers, neoprene and butyl rubber.

The effect of increasing the applied voltage, as far as the electron bombardment mechanism is concerned, is to increase the kinetic energy of the incident electrons. This results in an increase in range, subjecting a larger area of sample to corona, and an increase in penetrating power, causing more rapid degradation. Assuming that ionization efficiency of the incident electrons does not vary greatly with the relatively minor changes in electron velocity in the voltage range employed, time to corona failure should fall smoothly with increasing voltage.

Ozone generation, on the other hand, rises extremely rapidly with increasing voltage gradient across an air gap. Since ozone failure time of elastomers is, in general, linearly related to ozone concentration, the time to failure in corona attack, in any case where ozone attack is prominent, should fall, with increasing applied voltage, with the same precipitate speed. If ozone attack is an important

factor, time to corona failure should drop much more rapidly with increasing voltage than would be expected from the electron bombardment mechanism. This difference is realized experimentally. Neoprene and butyl rubber, both subject to some extent to ozone attack, show an exponential drop in time to corona failure with increasing voltage. This is so distinct as to divide the performance of these polymers into two regions; in the present series of experiments, below and above 15 kv. The behavior suggests the following conclusions. At voltage below 15 kv, *under the experimental conditions employed*, the concentrations of ozone generated were insufficient to affect materially the corona life of the cable. Under these conditions, reactions initiated by direct electron bombardment are of primary importance. At voltages above 15 kv, ozone concentration became sufficient to accelerate the degradative process, and the ability of a cable jacketed with typical neoprene or butyl compounds to resist corona attack at voltage in excess of 15 kv will depend, to a large extent, on their ozone resistance.

The corona resistance of polyethylene does not exhibit such behavior. Time to corona failure varies in a smooth, regular manner with applied voltage. This suggests that the degradation of polyethylene by electron bombardment during corona is not accelerated, at any reasonable voltage, by ozone attack.

Although it is well known that polyethylene is unaffected by the low concentrations of ozone commonly utilized in ozone test chambers, it was thought desirable to investigate its resistance under forcing conditions. In a series of experiments, polyethylene samples under stress were subjected to ozone concentrations as high as 0.1% by volume, with attendant conditions of high relative humidity, temperatures reaching 200°F, and incident ultraviolet irradiation. Previous experiments have indicated that these conditions accelerate the routine ozone exposure tests by five to ten orders of magnitude. No evidence of ozone attack was noted. It is felt therefore, that even under highly drastic conditions, polyethylene retains its essential invulnerability to ozone attack.

The recent study by McMahon and co-workers⁶ has shown that polyethylene is susceptible to corona attack even in nitrogen and carbon dioxide atmospheres. These results offer striking confirmation of the corona failure of polyethylene being due to a bombardment, rather than an ozonolytic phenomenon. The exact nature of the reactions initiated by electron bombardment remains rather vague⁵, and the need for considerable work in this area is clear.

It is clear that in the case of an unsaturated polymer, both electron bombardment and ozone attack must be considered. The applied voltage at which ozone concentration will become material will vary from case to case, depending on the ambient conditions and the inherent ozone resistance of the compound. In general, resistance to ozone attack will become increasingly important as the applied voltage is raised. The improvement of corona resistance of an unsaturated polymer must, ideally, consider both mechanisms. Corona resistant jackets should

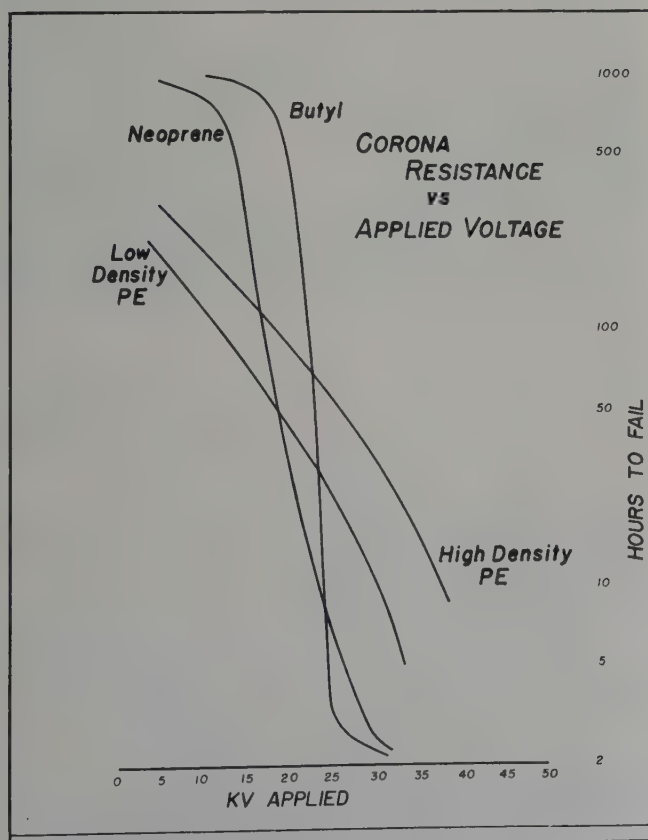
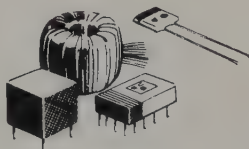


Figure 5, corona resistance vs applied voltage.

PERMANENT PROTECTION FOR ELECTRONIC COMPONENTS NEW TELEPOXY

a formulation breakthrough in resin systems for POTTING AND ENCAPSULATING ELECTRONIC COMPONENTS



TELEPOXY SYSTEMS are highly superior Insulating Compounds, made possible through Narmco's recondite research and advanced materials chemistry.

TELEPOXY ASSURES reliable performance from potted, encapsulated or coated components and sub-assemblies—even when they are subjected to extreme operating conditions.

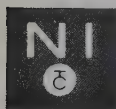
A
VARIETY OF
TELEPOXY
COMPOUNDS
ARE AVAILABLE.
EACH OFFERS:

UNEXCELLED physical and electrical properties
DIMENSIONAL STABILITY—negligible shrinkage during cure
EXTREMELY LOW moisture absorption
PROPER COEFFICIENTS OF THERMAL EXPANSION—for maximum protection of delicate components
SIMPLICITY of application

TYPICAL APPLICATIONS: Encapsulating toroidal transformers... discriminators... antenna-matching transformers... capacitors... ferrite pot cores... r-f chokes... inductors... semi-conductors... magnetic and vacuum tube amplifiers. Write for literature describing a variety of TELEPOXY formulations.

NARMCO... for high-performance materials.

Formulators of: Structural and Industrial Adhesives... Reinforced Plastic Laminating Materials... Ablative and Molding Compounds... Insulating Compounds.



NARMCO MATERIALS
Subsidiary **TELECOMPUTING CORPORATION**

600 Victoria Street, Costa Mesa, Calif. • Liberty 8-1144 • MADison 6-7923



SERVES THE NATION AND INDUSTRY WITH SYSTEMS AND SUB-SYSTEMS FOR CONTROLS, GUIDANCE, ELECTRONICS, TELEMETRY, DATA ANALYSIS, AND THEIR INTEGRAL COMPONENTS

Print Ins. 14 on Reader Service Card

be compounded both for ozone resistance and defense against free radical degradative reactions initiated by electron bombardment. Information concerning the latter point is, unfortunately, fragmentary at best. It appears that the incorporation of chlorine into the polymer is beneficial, perhaps because of the ability of carbon-chlorine bonds to dissipate energy transmitted by impinging electrons or ionized fragments in a non-destructive manner. This may explain the increase in corona resistance noted in going from polyethylene to "Hypalon," and from "Hypalon" to polyvinyl chloride. It is in line with the superior resistance of these materials to other types of radiation damage. It may be that other arrangements of atoms would greatly enhance the polymer's ability to absorb radiant energy in a harmless manner, without degradative effects. The need for such investigation is evident.

Acknowledgments

The author would like to thank William Beasley for electrical testing performed and stimulating discussion during the course of this investigation.

References

1. J. H. Mason, Proc. Inst. Elec. Eng., 98, Part I, 44-59 (1951).
2. T. W. Dakin, H. M. Philofsky, and W. G. Divens, Trans. Am. Inst. Elec. Engrs., 73, Part I, 155 (1954).
3. J. Crabtree, Review Ozone, B. S. Biggs, Rubber Reviews, 31, 1015 (1958).
4. C. D. Nail, Electronic Industries, 17, 74-77 (1958).
5. R. F. Grossman and W. Beasley, J. Applied Polymer Sci., 11, 163 (1959).
6. E. J. McMahon, D. E. Maloney, and J. R. Perkins, Trans. Am. Inst. Elec. Engrs., A. I. E. E. Paper No. 58-981.

Copaco

CLASS

A

ELECTRICAL INSULATING PAPER

- Dielectric strength — 300 volts per mil
- Density: 1.30 — 1.35
- Tensile strength — 13 — 16,000 lbs./Sq. In.
- Thickness from .004" to .030"
- 100% rag stock paper
- No sizing or fillers used.

"Glazed roll" finish — others available.
Can be combined with other materials.
Available in rolls, sheets or coils.

High Performance Electrical Insulators

COPACO — Highest grade 100% rag insulation paper

COPAREX — Economical grade 100% rag insulation paper

COPALAM — Class B asbestos — glass laminate insulation material

Write for free samples, literature and name of nearest Cottrell representative.

COTTRELL Paper Company, Inc.

10 Purchase St. Fall River, Mass.

470-9

Print Ins. 15 on Reader Service Card

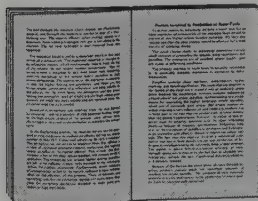
There's a lot of energy in noxious fumes!

Here are the facts: Heat Recovery from low-temperature, flameless catalytic fume oxidation is a practical, proven method of utilizing energy that would otherwise be lost to the atmosphere. In addition, catalytic oxidation destroys fumes and odors, eliminates noxious air pollutants, aids production, builds employee morale, reduces wear and corrosion of plant equipment, reduces fire hazards and improves insurance position.

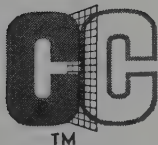
Catalytic Combustion pioneered the development and applications of catalysts in fume and odor control systems. Today more than 1,500 ovens in the wire enameling industry alone are using Catalytic Combustion systems. In addition many paint baking, metal decorating, paper printing, organic coating and curing and paper impregnating ovens and dryers are also profitably using catalytic oxidation systems.

Initial investment costs of catalyst elements on continuous ovens can often be recovered through heat recovery in a matter of months. Elimination of equipment downtime, safer, more healthful working conditions, and improved community relations, also contribute operating profits.

Catalytic Combustion elements are built to standard sizes and complete systems are custom engineered to maximum effectiveness.



Learn the facts about
Heat Recovery and Air Correction...
write "Department A"
for our brochure.



CATALYTIC COMBUSTION CORPORATION

4725 Fourteenth Street • Detroit 8, Michigan

A SUBSIDIARY OF UNIVERSAL OIL PRODUCTS COMPANY

Print Ins. 16 on Reader Service Card

The Folklore of Encapsulation

Does Resin Shrinkage Really Cause Failure?

By R. D. Engquist, R. B. Feuchtbaum, and F. Z. Keister, Hughes Aircraft Co., Culver City, Cal.



Figure 1, paper-base phenolic, etched circuit board with gold plated, flared eyelet. The solder joint failed during temperature cycling. Cause of failure: structural deficiency; not enough build-up of the solder fillet over the rim of the eyelet. (30 $\times$ magnification).



Figure 2, this photomicrograph shows failures on the 'plated-through hole' and the solder joint. Cause of failure: movement of the component lead while the solder joint is cooling. Notice the void around the component lead. This space is from .0008" to .0015" wide in this illustration. Voids of this type are susceptible to filling with resin. (50 $\times$).

EDITOR'S NOTE: Co-author Feuchtbaum suggests that a "folklore" item could be a regular *Insulation* feature . . . that there are many myths and legends that should be examined closely, as a service to the industry. He feels that there are probably many "Insulation Scientists" who would be only too happy to engage the "Insulation Soothsayers" in lively debate through *Insulation*. We agree . . . we will welcome (and pay for) contributions similar to this article.

Industrial processes, like life processes, are sometimes surrounded by a wealth of pseudo-technical folklore. One of the current maxims concerns the encapsulation of electronic modules. The maxim states, "Do not encapsulate, for the encapsulation resins break fine wires, open resistance welds, and in these and other ways render the module inoperative."

The villain, or causal factor, in these cases is referred to as "mismatched coefficient of expansion," or the "shrinkage of the resin."

The case is simple. Good modules are committed to an encapsulation process, and after encapsulation, when the resin has cooled and shrunk, the module no longer works. It is obvious that the resin must have done something. It is also just as obvious that the resin in its liquid state could not open the circuit; therefore, the hardening, cooling and shrinking processes must be to blame.

The Hughes Aircraft Company encountered this situation and investigated the phenomenon thoroughly. Except for one fact, the case for shrinkage seemed conclusive. The one outstanding contradictory fact was that seldom, if ever, did an encapsulated unit fail due to "opens" when it was cycled according to the required military temperature requirements. This was so even if the module was identical to and part of a batch of units that had a very high failure rate due to open circuits immediately after encapsulation.

With this fact in mind, a number of units that had failed after encapsulation were subjected to a process that repaired most of them and left no doubt as to the actual cause of the failures. The modules that were selected were wired with No. 40 magnet wire with a solderable enamel insulation. The solder connections were made to rather heavy .030" diameter terminals, and the physical location of the solder joint was close to the outside surface of the module, a distance of some .070- to .090-inch.

In many instances the liquid encapsulating resin, because of its excellent wetting properties, is able to penetrate all the cracks and voids of the unreliable solder joints. The resin is then set during the normal cure cycle, and the defective joint is insulated by the misplaced resin

causing an open circuit.

Failures of this type have been repeatedly repaired by holding a soldering iron to the terminals and reforming the defective solder joint inside the module. This method of repair is *only successful* in modules where the terminals are heavy enough to conduct the heat back into the area of the solder joint, and where the solder joints are close enough to the surface of the module so that enough heat will reach the joint to melt the defective solder joint and reform it as a functioning connection.

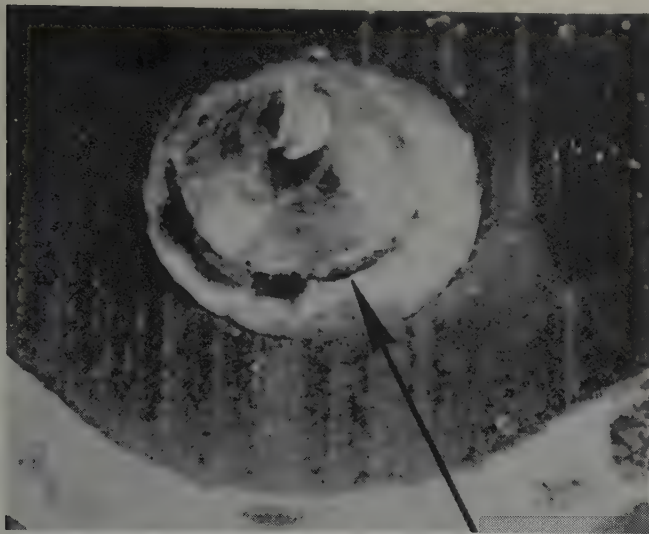


Figure 3, eyeletted, etched circuit board solder joint failure indicated by a circumferential discontinuity at the rim of the eyelet. (13X).



Figure 5, a plated-through hole failure due to excessive clenching pressure of component lead. The solder joint shows evidence of entrapped gas pockets and non-wetting of lead and hole wall. (48X)

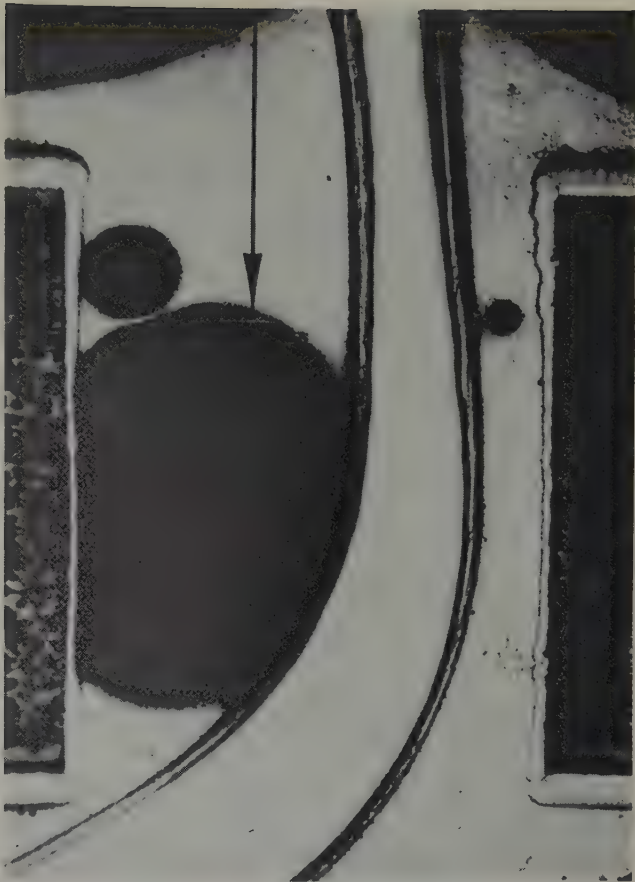


Figure 4, plated-through hole, etched circuit board solder joint weakened by entrapped flux gases and base material outgassing. (50X).



Figure 6, this photomicrograph illustrates how an external pinhole (arrow) can warn of a large internal void. (25X).

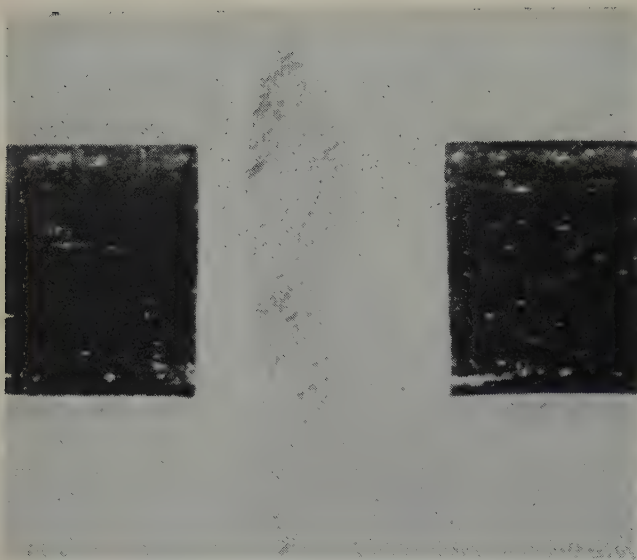


Figure 7, this photomicrograph demonstrates the appearance of a good solder joint. Notice how the solder has wet the surfaces, and the complete lack of the fine line voids illustrated in the other photographs. (20 $\times$).

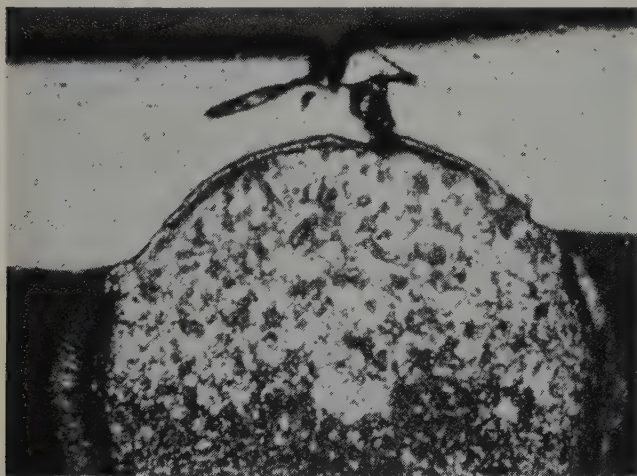


Figure 8, a photomicrograph of the cross section of a tinned copper, "A" nickel resistance weld. Note the crack in the nickel ribbon at the center of the weld. (120 $\times$).

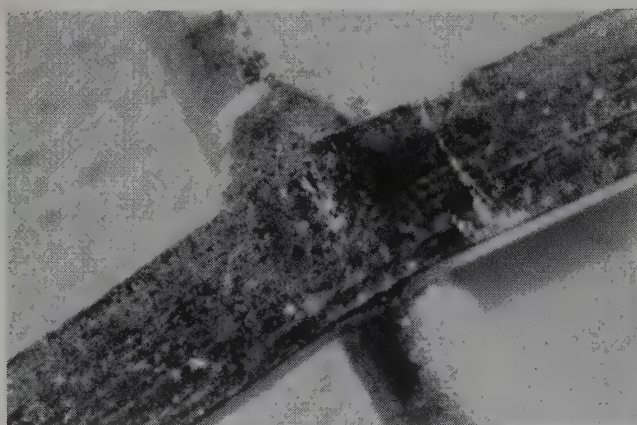


Figure 9, a welded interconnection between a .010" $\times$.031" "A" nickel ribbon and a .025" diameter tinned copper resistor lead wire. The weld is off center and cracked. Tensile tests conducted on this type of joint produced failures in the nickel ribbon under loads from .5 pound to 1.0 pound.

The institution of more stringent quality control measures on the lines where the connections were being made eliminated open circuits as a major cause of reject units for encapsulated modules. Therefore, at Hughes the encapsulation of modules has almost become an arm of quality control, since poor joints are detected before they leave the plant and they are corrected on the line making the connections, rather than by eliminating the process that shows up the deficiency.

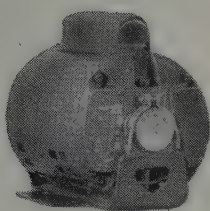
The accompanying photomicrographs illustrate some of the causes for failure in soldered and resistance weld connections. Many of these illustrations relate directly to the observations discussed in this paper.



Figure 10, a 22% nickel, 78% copper wire welded to a tinned copper wire. Both wires are nominally .025" in diameter. The excessive deformation of the weld, and the expulsion of metal at the edge of the weld, is caused by using excessive clamping force with an energy output that is too great for the size and material of the metals being joined.



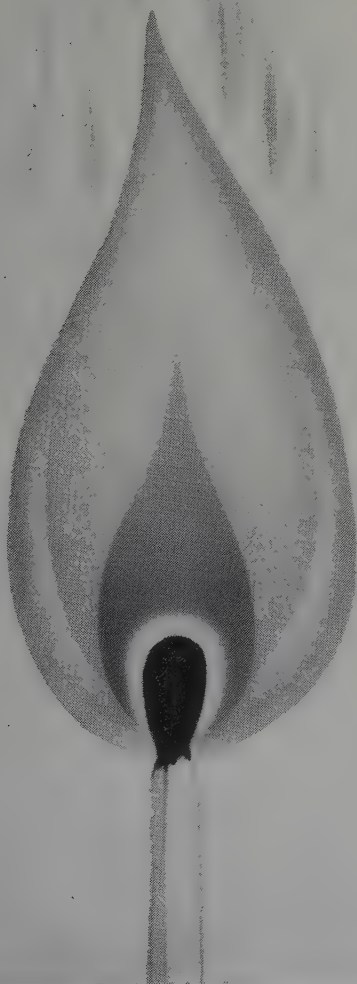
Figure 11, this photograph illustrates a typical, encapsulated, welded module. The component packaging density of this configuration is approximately 100,000 components to the cubic foot.



EVEN AT HIGH TEMPERATURES, MYLAR® HELPS MOTORS RUN TROUBLE-FREE LONGER!

Mylar* polyester film resists the three main causes of motor failure—heat, humidity and physical stress. Temperatures in the Class B range have relatively little effect on the electrical characteristics of “Mylar”. It’s also 35 times more moisture-repellent than rag paper . . . 8 times stronger . . . and can’t dry out because it contains no plasticizer. “Mylar” also helps reduce size and weight of motors, and gives them an extra safety margin from shock because it repels moisture so well.

Capacitors benefit from “Mylar”, too. Last longer, are more reliable . . . at no greater cost than paper units for similar service. In a wide variety of applications, “Mylar” can improve performance, lower costs. Here are some more reasons: • dielectric strength of 4,000 v/mil.** • thermal stability from -60°C . to over 150°C . • resistance to chemicals, aging, abrasion and tearing. Best of all, you can use less, often pay less . . . because you get all these advantages in thinner gauges. Evaluate “Mylar” for your product. Write for free booklet (SC) detailing properties and applications. Du Pont Co., Film Dept., Wilmington 98, Delaware.



REG. U.S. PAT. OFF.
BETTER THINGS FOR BETTER LIVING
... THROUGH CHEMISTRY



*Registered Du Pont Trademark.
**ASTM D-149.

Foams and Low Density Compounds

By Charles A. Harper, Materials & Processes Section, Engineering, Air Arm Div., Westinghouse Electric Corp., Baltimore.

Editor's Note: A considerable amount of information has been published on the more common embedding materials such as epoxies. However, although not widely publicized, some of the lesser known embedding products do deserve broader editorial coverage since their properties make them very suitable for some applications. This article is based on material in a book by Mr. Harper, to be published about May of this year,

itled "Electronic Packaging with Resins—A Practical Guide for Materials and Manufacturing Techniques," by McGraw-Hill Book Co., Inc.

Foams and low density compounds provide many of the advantages of high density embedding materials, while offering certain additional benefits. First, there is the obvious weight reduction benefit. This is often mandatory for many aircraft and missile applications, and is desirable for other

applications since low weight means easier handling and lower shipping charges. A second benefit is reduction of material costs. In explanation, a cost analysis based on cost per unit volume will often indicate that a foam or low density compound will be one of the most inexpensive embedding materials, although cost per unit weight might be high.

There are many types of foams and low density materials which are available commercially or which can be formulated for electronic packaging. The major types will be considered in this article. In general, it might be said that foams are produced by two methods: 1) the formation of gas as part of the chemical reaction in the production of the foam material, and 2) the generation or evolution of a gas which is created by the decomposition of a blowing agent which has been added to the reacting materials. A blowing agent is merely some material which will liberate gas at the reaction temperatures.

Non-foamed low density compounds are usually formulated by the addition of a low density filler to the base resin.

URETHANE FOAMS

Perhaps the most widely used foam-in-place embedment materials are urethane foams. Basically, urethane foams are the reaction products of polyfunctional isocyanates with materials containing two or more active hydrogen atoms, such as polyesters, polyethers, glycols, and water.

Nature of Urethane Foams

For illustration, consider the urethane foams produced by the reaction between some polyester resins and a diisocyanate. Each individual polyester resin will produce a different end product when reacted with a diisocyanate. The molecular weight of the polyester, amount of polyester in the reaction, distance between reac-

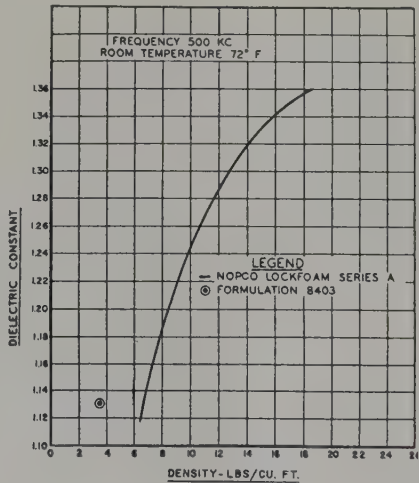
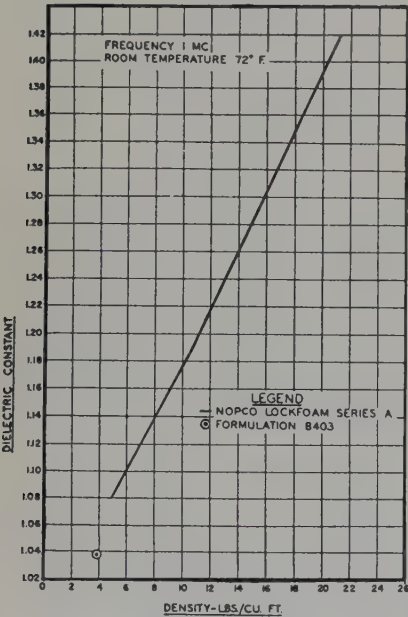


Figure 1, dielectric constant as a function of urethane foam density at two frequencies.

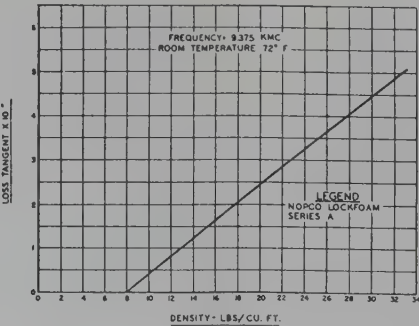
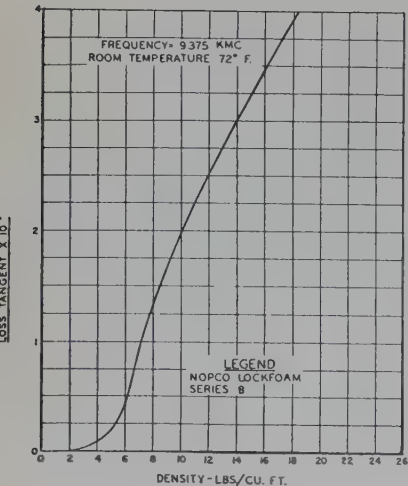
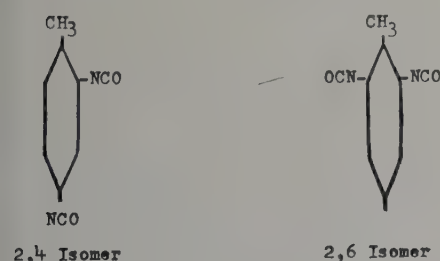


Figure 2, loss tangent as a function of urethane foam density for two materials.

Figure 3, photos show urethane foaming process sequence. Materials are mixed, poured, and foamed in place. Next to last photo shows foaming nearly completed in less than three minutes. Courtesy E. I. du Pont de Nemours & Co., Inc.

tive points on the polyester molecule, and other features of its structure are a few of the more important chemical characteristics of the polyester which affect the nature of the final urethane polymer. For instance, low molecular weight or a large amount of branching in the polyester leads to a more rigid foam, while increasing molecular weight and increasing the distance between reactive points leads to the resilient and flexible type urethane polymers. The rigid foams find the greatest use in embedded electronic packaging. Therefore, all of the systems described here, except polyether urethane foams, are rigid foams.

The particular diisocyanate used in producing a urethane foam has a smaller (but still important) effect on the properties of the final urethane polymer. The diisocyanate of widest use is known as TDI (toluene diisocyanate) which is a mixture of the two isomeric diisocyanates shown below. The usual mixture of TDI is approximately 80% of the 2,4 isomer and 20% of the 2,6 isomer.



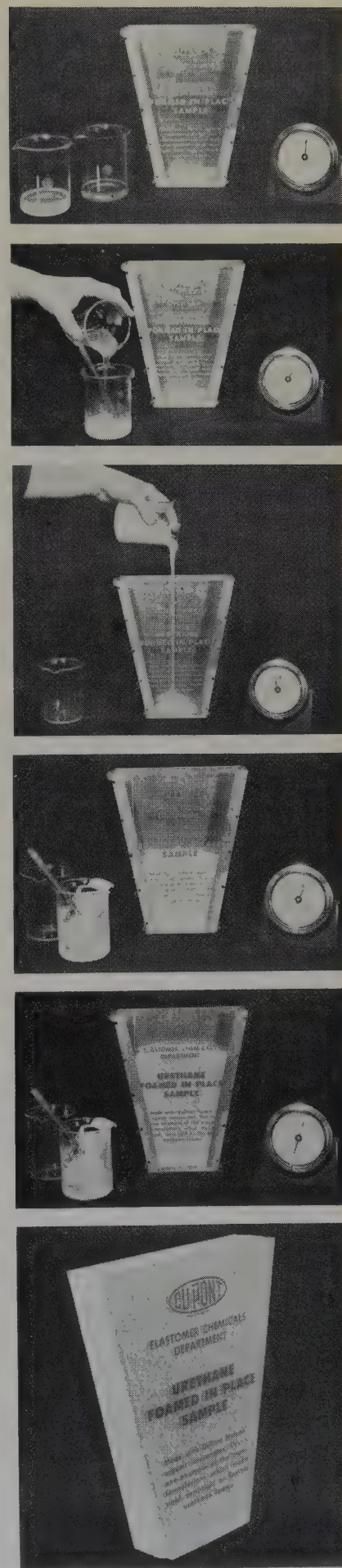
The reactive group in the diisocyanate is the NCO group which is known as the isocyanate group. Up to this point, we have discussed only the reaction between the diisocyanate and a polyester. Actually, this reaction would merely result in a solid high density end product rather than a low density foam. The other reactant required to produce the foam is water or some similar material which will react with the isocyanate group to liberate carbon dioxide gas. We will consider water for illustration. In the

production of a urethane foam there are two major reactions occurring simultaneously: 1) the reaction between the polyester and the diisocyanate to form the urethane polymer, and 2) the reaction between the diisocyanate and the water to form the carbon dioxide gas which causes the urethane polymer to expand and entrap the carbon dioxide, thus resulting in a foam material. Thus, the density of the urethane foam can be controlled by the ratio of the diisocyanate and water. As more water and diisocyanate react, more carbon dioxide is liberated to create a lower density foam product.

There are two other materials which are used in the reaction to produce urethane foams. One is a catalyst and the other an emulsifier. Catalysts are commonly used to control the curing rate of the urethane reaction. Curing rates may be controlled within limits by varying both the amount and type of catalyst. Increasing catalyst concentration usually results in a faster cure and shorter working time or pot life. Since the urethane foam reaction is normally very rapid, often with less than a minute being available for mixing and pouring, it is necessary to reach a compromise between working life after adding catalyst and the cure time.

Since it is often difficult to obtain a good uniform mixture of the diisocyanate and polyester due to the high viscosity of the polyester and the low viscosity of the diisocyanate, it is common practice to add a surface active agent or emulsifier. The addition of emulsifier helps to produce foams with finer and more uniform cell structure.

One very useful feature of foams is that properties can be varied by varying the foam density. Figures 1 and 2 show the variation of dielectric constant and loss tangent with density for two frequencies. Most other properties also exhibit a similar gradient



with density variation.

Prepolymer and One Shot Urethane Foams

In addition to classifying foams by their flexibility or rigidity and by their density, urethane foams are also typed according to whether they are prepolymer or one shot urethane foams. The "one shot" designation is used to describe systems where the end user mixes all of the ingredients. Hence, the entire reaction is completed in one shot.

It is often desirable to modify this method of making a foamed part. First, since the reaction is extremely rapid and since the viscosities and other relationships between all mate-

rials can lead to difficult handling, it is often preferable to reduce the number of components being mixed at one time by premixing the basic ingredients into two separate mixtures which can be blended together for the foaming reaction. Care must be taken to be sure that the materials are mixed in such a way that no reaction is initiated until final blending.

However, there are two other disadvantages to this method. First, the diisocyanate is extremely toxic and irritating to the eyes and respiratory system. Thus, working with the TDI as a raw material is often undesirable for the end user. Second, the reaction often produces a very high exothermic temperature so that in many cases the

center or core of the foamed part is charred. This is especially true as the size of the foamed part increases.

It is possible to overcome these objections by using the prepolymer system. In the prepolymer system, the resin manufacturer partially reacts the diisocyanate and the polyester to form what is called a prepolymer. Then a two part system is marketed—one part being the partially polymerized diisocyanate-polyester resin in which very little free diisocyanate is present, and the other part being the catalyst. Then, by mixing the catalyst and the prepolymer resin, the end user produces the foamed part.

Processing and Product Properties of Various Urethane Foams

Since base materials in a urethane resin system can be combined in various ways, more detailed descriptions of some representative systems will be helpful to the reader who is unfamiliar with urethane foams. Three representative systems will be described.

A. One Shot Systems

Typical of a multi-component one shot system is the formulation given as follows, wherein the end user works with all of the basic materials.

Table 1, Properties of a Typical Multi-Component One Shot Urethane Foam	
Property	Value
Density, lbs/cu ft	1.8-2.2
% Closed Cells	85-90
Compressive Strength (at yield point), psi	15-25
Elevated Temp. (24 hours at 250°F)	No dimensional change
Humid Aging (158°F, 90-100% RH, 7 days)	No dimensional change
Water Immersion after 24 hours at 75°F	
Dimensional Stability	No dimensional change
Water Absorption, lbs/sq ft	0.05
Thermal Conductivity, BTU/sq ft/hr/°F/in at 75°F	0.25
Dielectric Strength, vpm, 1/8" sample	110-150
Chemical Resistance	Unaffected by grease, oils, dilute acids and alkalies, and most common organic solvents.

Material	Parts by Weight
Polyester	100.0
Water	4.0
Emulsifier	1.0
Catalyst (N-Methylmorpholine)	1.0
Diisocyanate	170.0

Table 2, Properties of a Typical Two Component One Shot Urethane Foam			
Property	Room Temp.	200°F	-40°F
Tensile Strength, Flatwise, psi	157.9	118	122
Elongation per Inch, %	6.9	6.2	2.2
Modulus of Elasticity, psi	2532	1159	2860
Shear Strength, psi	73	40.4	40.3
Shear Strain in Radians	.341	.26	.17
Modulus of Rigidity, psi	238	216	277
Compressive Yield Strength, Flatwise, psi	109.5	74.1	118
Deformation at Yield Point, %	5.3	5.7	3.3
Modulus of Rigidity, psi	2743	1803	3097
Power Factor and Dielectric Constant			
Freq. (cps)	Capacitance (mmfd)	Power Factor	Dielectric Constant
10 ³	23.3	.002	1.10
30 x 10 ⁶	27.0	.002	1.30

The first step in the production of the rigid foam is the preparation of a premix of the polyester, water, emulsifier (surfactant), and catalyst by stirring at a slow or moderate speed until a completely homogeneous mixture is obtained. This may require from one half to one hour. Care should be taken to introduce into the mixture as little air as possible, since air bubbles in the premix tend to yield non-uniform foams. The premix may be made in any size batch, provided it is protected from loss of moisture both during storage and use.

Incorporation of the diisocyanate is done either batchwise or in a con-

Table 3. Properties of Typical Prepolymer Urethane Foams

Foam Density (lbs. per cu. ft.)	2	4	6	10	16	20	Test Spec.
Linear Thermal Coefficient of Expansion Between -30°C and $+30^{\circ}\text{C}$ (10^5 in/in/ $^{\circ}\text{C}$)	2.48				9.25		ASTM D696-44
"K" Factor at 77°F (BTU/Hr/Ft ^{2} / $^{\circ}\text{F}$ /In)	.21		.23	.25		.30	
<i>Mechanical Properties</i>							
Core Density (lbs per cu ft)	2	4	6	10	16	20	
Compressive Yield Strength, .2% offset (psi)	4.5	21		115	—	335	ASTM 695-52T
Compression to produce 50% deformation (psi)	9.5	40		220	—	600	ASTM 696-52T
Ultimate Tensile Strength (psi)	16	42		140	280	370	ASTM C297-52T D638-52T
<i>Electrical Properties</i>							
Power Factor at 10^3 cps	0.003						
Dielectric Constant at 10^3 cps	1.42						ASTM 150-47T

tinuous mixing mechanism, depending upon the application. Since foaming begins within 30 to 60 seconds from the time the diisocyanate is added to the premix, only a few minutes are allowed for both mixing and pouring.

The proper amount of premix is weighed into a container in the batch process, diisocyanate is then added, and the mixture is stirred rapidly and thoroughly for 20-30 seconds, or until a homogeneous mixture is obtained.

Thorough mixing is highly important. Insufficient mixing will result in a non-uniform cell structure, while excessive mixing critically reduces the time available for pouring the foam into the mold.

It is recommended that closed molds be vented with small openings approximately 1/16 inch in diameter, in appropriate locations, to permit the displacement of air.

Where identical conditions are used, there will be very little variation in density from batch to batch. Larger volumes of foam give slightly lower densities due to a smaller ratio of skin to foam and to the higher internal temperature produced by the exothermic reaction. Thin sections and closed molds lead to the development of higher pressures which naturally increase the density of the piece. It is important that the temperature of the mold be kept constant from batch to batch to avoid variations in density. As temperature is increased, the den-

sity will decrease.

The foam will attain nearly maximum physical properties after standing several hours at room temperature but the ultimate strength is only achieved after one to seven days depending upon the shape and volume of the mold. The rate of cure can be accelerated by heating the foam to 150 - 230°F for one to four hours. The time of cure will depend upon the shape and volume of the piece.

A slight surface brittleness may be evident after the initial setting of the foam. However, foams can be handled at once provided care is exercised in not damaging the surface. After curing, this brittleness disappears leaving a tough, non-friable article.

Physical properties of this first type of one shot foam are given in table 1.

In the one shot system just described, all of the basic ingredients are blended in by the user of the foam system. It will be noted, however, that preceding the foaming reaction, the polyester, water, emulsifier, and catalyst were premixed into one component blend, with the diisocyanate constituting the second component. Later, this type of two-component system, or some variation, is marketed for the convenience of the end user. This type of system cannot be called prepolymer, however, since the diisocyanate and polyester are not partially prepolymerized.

Properties of a representative system of this type are given in table 2.

B. Prepolymer Systems

Prepolymer systems are two-component systems where the polyester and diisocyanate have been partially prepolymerized. A prepolymer resin can be recognized in two ways. First, the diisocyanate odor is weak, but is present in sufficient concentration to be easily recognized. Secondly, the second component is normally used in catalytic quantities; that is, under 10 parts of catalyst per 100 parts of resin.

Processing is generally similar for prepolymer and one shot systems. The mixing must be rapid, since the urethane foam reaction is very fast. The exothermic heat is sufficient to cure the foamed part so that it can be handled within a couple of hours after the resin has been catalyzed. Usually, however, one to seven days of room temperature cure is required for the foam to fully develop its properties. A moderate oven cure will accelerate this.

Properties of some typical prepolymer foams are given in table 3.

Polyether Urethane Foams

A major modification to the polyester urethane foam system exists in what is known as the polyether urethane foam, or often more briefly called polyether foam. The prime chemical difference between polyester urethane foams and polyether urethane foams is, as the name would imply, the replacement of polyesters

by polyethers as the active hydrogen containing reactant in the urethane foam reaction.

With this change in the chemical nature of the polymer, some major differences and properties result. For instance, the compression of a polyether foam with increasing compressive load is much smoother than the compression of the polyester foam under a similar compressive load.

Another factor considered to be an advantage for the polyether foam materials is that their low temperature flexibility is better than that of the polyester type urethane foams.

The polyether foams are considered to be more resistant to solvents than the polyester foams. Also, the resistance to humidity aging is reported to be considerably improved over the polyester foams.

Controlling Diisocyanate Hazards

Due to the widespread use of urethane foams and the potential hazards associated with the isocyanates in the reaction, an analytical monitoring kit has been developed for use with urethane or diisocyanate systems. This kit is available from Mine Safety Appliances Co.

EPOXY FOAMS

In general, epoxy foams are produced by the action of a blowing agent which is added to the epoxy resin. When heated, the blowing agent or foaming agent decomposes, releasing a gas which causes the epoxy resin to expand into foam cells during the reaction. Producing a foam in this fashion requires extremely good control of all conditions, since it is imperative that the epoxy reaction and

the liberation of gas from the blowing agent be simultaneous. If the gas is liberated from the blowing agent too early, the gas will merely escape and little or no actual foam will result. Likewise, if the epoxy reaction is completed before the liberation of gas from the blowing agent, the epoxy material will be too hard or viscous for foaming to occur, and only a solid epoxy material will result. Thus, an exact relationship must be maintained between resin, hardener, temperatures, viscosities, and other variables.

A procedure for the preparation of foamed epoxy resin in small volumes is given as follows.

Mix 2 grams of blowing agent with 5 ml of toluene and 2 drops of wetting agent. Add this to 100 grams of epoxy resin which has been heated to 110° C. Mix thoroughly and then quickly stir in 6 grams of diethylene triamine. This quantity of material will start to foam in about 30 seconds, and will produce a foam of approximately 7 pounds/cubic foot density.

It has been found that the toughest foams are produced by baking the resin 1 to 2 hours after foaming at 75 to 100°C. to insure complete cure of the resin. This is preferably done before cooling the part, since the low thermal conductivity of the foam makes it slow to reheat, especially the inner portions of thick sections.

Since development and control of a foam epoxy system is sometimes difficult for the end user, it has been common for the end user to employ formulated systems. These are either one or two-component systems, depending on the activity of the catalyst. The use of these formulated systems is usually easy, normally involving only mixing, heating, and curing operations.

Properties of two typical epoxy foams are shown in table 4.

PHENOLIC FOAMS

Phenolic resins can be converted into a foam end product rather than the solid end product by using a chemical blowing process. As when formulating high density solid phenolic material, the formulation usually consists of the liquid resin and curing agents or accelerators. In addition, a

Table 4, Properties of Typical Epoxy Foams			
Property	Test Method ¹	Value	
Density, lb/ft ³	AMS 3730 ²	5	7
Compressive Strength, psi	AMS 3730 ²	82	110
Tensile Strength, psi	Forest Products Lab USDA Bulletin #1555	98	76
Softening Temp., °F	AMS 3730 ²	291	226
Buoyance, lb/ft ³	AMS 3730 ²	55	51
Thermal Conductivity BTU/hr/ft ² /°F/in	Cenco-Fitch	.28	.238
Moisture Absorp., 24 hrs, %	MH Test No. 3 ³	1.5	1.3
Pot Life	Room Temp.	4 to 10 hours	Months of enclosed

¹These values are determined on free foamed laboratory specimens. Restrictions to flow may produce different densities.

²Aeronautical Material Specification.

³Minneapolis-Honeywell Regulator Company Test.

Table 5, Properties of Some Phenolic Foams			
Property	1-3 Lb/ Cu Ft. Density	5-7 Lb/ Cu Ft Density	8-10 Lb/ Cu Ft Density
Compressive Strength, psi	5-22	45-90	120-220
Tensile Strength, psi		13-31	39-58
Shear Strength, psi		10-22	27-38
Modulus of Elasticity, psi			5100 Compression
Flammability	Self-extinguishing.		
Fabrication	Easily fabricated with knife, saw, etc.		
Heat Resistance	Up to 300°F continuous		

blowing agent must be added to the mixture to produce the foamed resin. The reaction between the resin and the acid curing agent is exothermic. The heat from this reaction is utilized to decompose the blowing agents, thus liberating the gas in the blowing agent. Also, as in the production of other foams, additional ingredients such as emulsifiers, etc. are often added to control density, cell size, and other desired characteristics. The phenolic foaming process, like the other foaming processes, involves a fast reaction.

Most of the properties of the foamed phenolic resin are similar to those of the base phenolic resin. Outstanding properties are considered to be thermal insulation, and chemical resistance, except in the presence of certain alkalis, ketones, and alcohols. Table 5 shows some properties for a typical phenolic foam.

Since the phenolic foam materials are considered to be relatively low-cost materials compared to certain other foam materials, very low density cured phenolic foams (under 1 lb per cu ft) are being used for economical packaging materials. Although the cured phenolic foams are useful in packaging electronic components for shipping, they are not often usable for foam-in-place packaging of most electronic circuits. The reasons are the same as for solid phenolic casting resins, primary among which is the corroding effect of the acid catalysts used with phenolic resins.

Foams may be produced having a density as low as 0.3 to 0.4 pounds per cubic foot (about 1/10 the weight of loosely packed shredded paper) with sufficient mechanical strength to allow use as a cushioning material.

During the foaming process, the resin changes rapidly from a free flowing liquid to an infusible cellular solid. A proper balance of reaction and expansion can result in the formation of a foam having a volume as much as 200 times greater than the original liquid resin.

SILICONE FOAMS

For high temperature applications requiring some of the advantages of foams, such as low density or high

Table 6. Typical Properties of Rigid Silicone Foams			
	Open Pan Foam Formulation		
	R-7001	R-7002	R-7003
Expansion Temperature, °F	320	320	320
Density, lb/cu ft	12	14	16
Cell Size, inch diam., less than	0.08	0.08	0.08
Compressive Strength, psi			
at 77°F	100	200	325
at 77°F, after 200 hr at 500°F	100	190	210
at 500°F, after ½ hr at 500°F	5	25	70
at 500°F, after 200 hr at 500°F	20	45	80
Weight, Loss, %			
during expansion	1.2	1.3	1.0
after 1000 hr at 500°F	3.5	2.6	2.6
after 1000 hr at 570°F	8.0	4.2	4.2
after 72 hr at 700°F	8.5	5.2	5.2
Water Absorption, % by weight, after 24 hr immersion	3.2	2.3	2.1
Heat Distortion Temp., °F	700	700	700
Flame Resistance	Do Not Burn		
Dielectric Constant at 10 ⁵ cycles	1.23	1.25	1.26
Power Factor at 10 ⁵ cycles	0.0004	0.00102	0.00105
Thermal Conductivity, BTU/hr/sq ft/°F/inch thickness	0.3	0.3	0.3

Note: R-7001 and R-7002 can be foamed in place. Dow Corning Corp.

thermal insulation, silicone foams offer advantages. Both rigid and flexible silicone foaming resins are available.

The rigid silicone foaming resins are one-component, dry, granular powders. Thus, they require no additional mixing, catalyst, or other components. The foaming materials are non-toxic. Therefore, users do not have to be concerned about protection against hazardous gases. Atmospheric pressure and humidity conditions have negligible effects on their foaming action.

Foaming is performed at atmospheric pressures and the internal pressure exerted by the foam itself is practically negligible. The mold or cavity to be filled does not have to be preheated. The powders melt and expand readily on heating.

Foamed structures made from these silicone materials are exceptionally heat stable and resistant to thermal shock. They are usable at temperatures above those normally limiting the use of organic foam resins. These characteristics, in com-

bination with good physical and electrical properties and low water absorption, make these foams durable electrical and thermal insulators.

Their heat stability is indicated by the fact that they will not distort when heated to 700°F. Test samples exposed to a temperature of 700°F for over 50 hours showed only slight structural change and low weight loss. Similar samples heated to red heat by direct flame did not burn and showed only slight surface change.

Properly foamed, each of these materials has a uniform, multipore structure that is predominantly spherical and unicellular. Typical properties of three rigid silicone foams are shown in table 6.

Silicone foams are also available as flexible foam-in-place resins which may be useful for certain electronic packaging applications. A typical material is available as a two-component liquid system. This resin has a pourable pot life of about 30 minutes, and can be cured in 16-24 hours at room temperature or 2-3 hours at 65°C. The usual foam density is about 20-

Table 7, Properties of a Resilient Silicone Foam (7-13)

Property	Method	Value
Color		Tan
Specific Gravity		1.10
Density Liquid Resin, lbs/cu ft		68.6
Foam Density, lbs/cu ft		20-25
Pot Life, minutes at 25°C		30-45
Viscosity, cps at 25°C	Brookfield	20,000
Tensile Strength ($\frac{1}{4}$ " x $\frac{1}{2}$ " specimen), psi		60
Elongation ($\frac{1}{4}$ " x $\frac{1}{2}$ " specimen), %		80
Moisture Absorption, % at 90% RH, 24 Hours		0.01
Solvent Resistance:		
Polar solvents		Good
Aromatic hydrocarbon and chlorinated solvents		Swells
Dielectric Strength, volts, $\frac{1}{4}$ " specimen	ASTM-D149	6,000
Dielectric Constant, 100 cycles 25°C	ASTM-D150	2.8
Volume Resistivity, ohms/cm at 50% RH at 25°C	ASTM-D256	1.8×10^{13}
Surface Resistivity, ohms at 50% RH 25°C	ASTM-D257	1.4×10^{15}

25 pounds per cubic foot, although the density can be reduced somewhat by curing at higher temperatures.

Typical properties of a resilient silicone foam are given in table 7.

Their combination of high temperature capabilities and power factor presents another interesting application area for silicone foams, namely, use for high power, high frequency applications. One interesting thing to consider here is that the power factor for the various foams is reduced as the density of the foam is decreased. This might lead to the conclusion that any foam would have sufficiently low power factor for high frequency, high power applications if the foam density were low enough. However, since the cell walls of the foams actually represent a solid material, the cell wall may be affected similarly to any other rigid material. Thus, electrical loss properties of the base material must be taken into consideration.

Although not widely used for foam-in-place applications, polyethylene can be foamed-in-place in some instances, and has loss properties which can be attractive for high frequency applications.

FOAMED-IN-PLACE POLYSTYRENE

Although polystyrene foams are most widely used as prefoamed boards or planks, there are cases where foamed-in-place polystyrene foams are used. They have advantages in cost and ease of use for certain applications. Uniformity in cell structure is good, since the foamed-in-place polystyrene is actually a thermal expansion of polystyrene beads of uniform size.

Polystyrene for foam-in-place application is available in white or colored beads, which upon placing in a mold and heating, will expand and fuse together into a strong, lightweight foam with very uniform closed cells. The density of the final foam is controlled by the amount of beads put into the mold, and is usually between 1 and 15 pounds per cubic foot. The finished foamed part comes from the mold with a hard smooth skin which improves strength properties. One limitation of polystyrene foams, however, is that they cannot be used nor-

Table 8, Typical Electrical Properties of Foamed-in-Place Polystyrene

Property	73°F, 50% RH	48 hrs @ 50°C	96 hrs @ 35°C & 96% RH
Dielectric Constant			
60 cps	1.19	1.24	1.24
1,000 cps	1.07	1.06	1.05
1,000,000 cps	1.02	1.05	1.05
Dissipation Factor	<0.0005	<0.0005	<0.0005
Loss Factor	<0.0006	<0.0006	<0.0006
Volume Resistivity, Megohm-in.	$>1.5 \times 10^7$	$>1.5 \times 10^7$	$>1.5 \times 10^7$
Volume Resistivity, Ohm-cm.	$>3.8 \times 10^{13}$	$>3.8 \times 10^{13}$	$>3.8 \times 10^{13}$
Surface Resistivity, Megohms	$>9.8 \times 10^6$	$>9.8 \times 10^6$	$>9.8 \times 10^6$
Dielectric* Strength, Volts/Mil	48	50	48
Dielectric† Strength, Volts/Mil	49	49	49

*Short time †Step by step
Arc resistance—none; melts at first spark

nally above 175°F. Electrical properties of a foamed-in-place polystyrene foam are given in table 8.

Polystyrene beads can be expanded in several ways. They can be expanded in molds which are heated by either hot air or steam, or they can be expanded by the direct introduction of dry steam into the mold cavity. Expansion temperatures are in the range of 230 to 270°F. Steam pressures range between 10 and 30 psi. As in the production of other foams, expansion cycles or foaming cycles are not long. The actual cycle for foamed polystyrene can be up to three minutes for sections a foot thick or so but is as short as ten seconds for very small pieces. These would be the times used when expanding the polystyrene by the direct introduction of dry steam. For externally heated molds, foaming cycles would approximate ten minutes for half-inch thick sections or twenty minutes for one-inch thick sections.

Since this material is thermoplastic, the molds must be cooled after the foam is produced so that the foam will have sufficient strength to be removed from the mold and maintain its shape. Cooling cycles will range from 30 seconds for small parts to 15 minutes or so for sections 12 inches thick. Cooling should be gradual.

An interesting technique has been reported for the expansion of polystyrene beads. This technique is based upon formulated mixtures of the polystyrene beads and exothermic thermosetting resins such as epoxies. The foaming is accomplished by the exothermic heat during the cure of the thermosetting resin. This heat softens and expands the polystyrene beads which contain the expandable gas. In parts produced by this technique, the thermosetting resin forms a hard, resin-rich surface on the part and acts as a binder which bonds the expanded granules together.

LOW DENSITY COMPOUNDS FROM LOW DENSITY FILLERS

Another type of low density material for use in embedded electronic packaging is made by incorporating low density fillers with resins such as polyesters, epoxies, etc. These com-

pounds differ from foams chemically in that the low density is produced by bulk effect rather than by a chemical or gassing reaction. Thus, the actual density of the final compound is controlled by the quantity of the low density filler which can be incorporated into the resin and by the type of filler employed. It does not necessarily follow however, that a lower density filler will produce a lower density compound of the same working properties. The reason for this is that the lower density filler might have a thixotropic effect on the resin, thereby allowing less filler to be incorporated into the resin for a given viscosity or pourability. This practical limitation to the amount of low density filler used in turn limits the final compound density which can be obtained.

While appreciable weight reduction is possible using low density fillers, the specific gravity of the low density filler filled compounds is still considerably higher than that obtainable with foams. Nevertheless, when the weight reductions are satisfactory, compounds produced through the addition of low density fillers will be physically stronger than will foamed-in-place packages. Also, since there is a larger percentage of resin in the low density filler compound, such compounds will normally have better resistance to humidity and other environmental effects than will foaming resins. Indeed, foams are inadequate in certain cases due to their weaknesses in environmental extremes. Low density filled compounds are far more reliable under these conditions, and thus represent the only satisfactory approach to weight reduction in these instances.

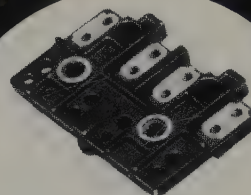
ACKNOWLEDGEMENTS

Acknowledgement is made to the following companies for certain parts of the information and data presented in this article: Nopco Chemical Co., Allied Chemical Corp., Isocyanate Products, Inc., Mine Safety Appliances Co., Shell Chemical Corp., Minneapolis-Honeywell Regulator Co., Dow Chemical Co., Minnesota Mining and Manufacturing Co., Koppers Co., and Westinghouse Electric Corp.



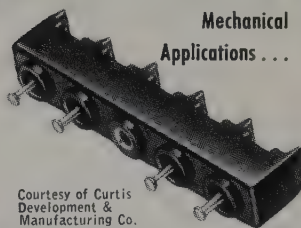
CAN DELIVER

Molded Inserts

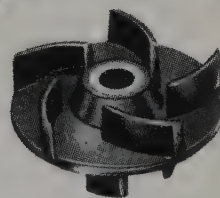


Combining Plastics & Metals
with Efficient Performance
Properties

For Electrical and
Mechanical
Applications . . .



Courtesy of Curtis
Development &
Manufacturing Co.



Inserts securely and accurately located
for dependable ready-to-assemble
components

SEND YOUR PRINTS
FOR QUOTATION

**Midwest
Molding**
AND MANUFACTURING COMPANY

PLASTICS
CUSTOM-ENGINEERED

789 ROTARY DRIVE
GURNEE, ILLINOIS

Print Ins. 18 on Reader Service Card

Test Methods and Apparatus For Improving Capacitor Paper

By L. W. Stiles, Crocker, Burbank and Co. Ass'n., Fitchburg, Mass., and J. D. Stacy, Consulting Engineer.

The progress in the development of paper capacitors over the past 40 years has been largely due to improvement of the materials. Of these materials, capacitor paper has progressed at a spectacular rate. The original .0005" linen paper with about 200 conducting particles per square foot and almost unknown chemical and formation characteristics can be compared to the kraft and modified kraft papers of today, in which the same thickness has no more than one conducting particle per square foot. Present-day papers offer the capacitor designer a vastly improved product with tightly controlled chemical and physical characteristics. They have been used effectively to reduce size, to increase the maximum unit ratings, to add to reliability, and to enhance the electrical characteristics of dissipation factor and insulation resistance.

In the past, this progress has been through the cooperative testing by the capacitor manufacturers of many paper trials produced by modifications of the papermaking process. In some cases, the modification has been suggested by the capacitor manufacturer; for instance, the low loss machine finished paper covered by Hopkins and Sproull patent 2,505,545. But, even so, the paper manufacturer has contributed his knowledge of the papermaking science and art to bring the new product to the reproducible manufacturing stage with the necessary physical characteristics.

There is evidence that there is room for still further improvement in capacitor paper through process developments leading to better control of uniformity and chemical constituents. There are many variables in the papermaking process where minor improvements are possible. To study these possible advances by the old method of running a small lot of paper, submitting samples to capacitor manufacturers and waiting months, or even

years for their reports (frequently they did not agree) was practically impossible. In consequence, our firm decided to install facilities to wind, assemble, impregnate, and test capacitor units of standard designs in order to give a better evaluation of the paper than was heretofore possible with the wide variety of units in which the capacitor manufacturers tested the product.

These facilities permit evaluation of the following types of variables: (a) physical, involving the type of pulp, the beating process, the wire size, machine speed, the type of felts, moisture content at the calenders, and the density; (b) chemical, involving the cellulose components, the type and amount of ionic or ion-producing contaminants and stabilizers.

A further important application of these facilities is to evaluate production lots of paper and to build up a fund of information on the degree of uniformity in electrical characteristics and life currently experienced in order to be able to measure the degree of improvement made.

Facilities used in this project are: small winding machine in air-conditioned room, treating tank and vacuum pump, Fuller's earth filtration equipment and insulation resistance test cell, conditioning oven, microammeter and dissipation factor bridge, life test ovens for a-c and d-c life tests, and power supplies—group regulated a-c and individually regulated d-c.

Standard test samples of 1.0 and 0.55 μ f are used for a-c testing. These are wound with the foil on the outer turns of units to fit in $1\frac{1}{4}$ " $\times$ $2\frac{1}{16}$ " ballast capacitor cans. This type of sample diminishes the effect of hot-spot temperature and introduces an excess of paper to accelerate the effect of any diffusible contaminant. Two foil widths are used to enable close coordination with customer tests.

Glass bushings are used to mini-

mize the chance of contamination from bushing materials. Cans and covers are pre-tinned and then thoroughly cleaned. By this procedure, covers can be soldered to cans without addition of fluxes. This eliminates one possible cause of contamination.

The drying and impregnation cycle has been selected from the results of a number of trial runs of the equipment which indicated the best uniformity and optimum values of dissipation factor and insulation resistance. The cycle is of the so-called "broken vacuum type," similar to that taught by Clark patent 1,866,346 (now expired). The following cycle selected permits completion of tests at 125°C within 24 hours of the start of a test run:

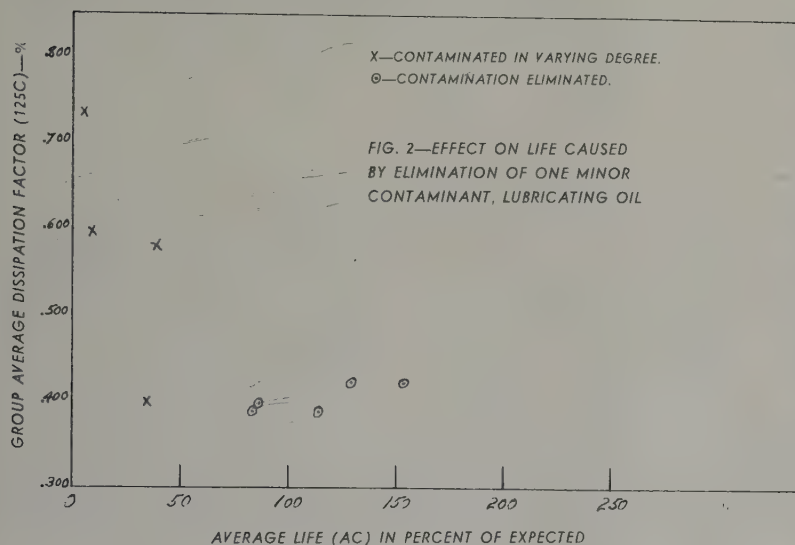
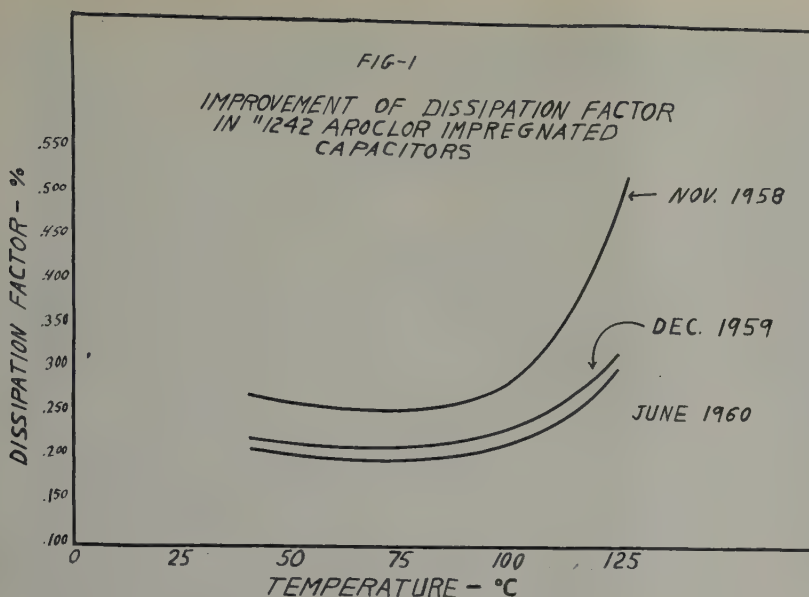
- 1) 16 hours of broken vacuum; $\frac{1}{2}$ hour of vacuum, $\frac{1}{2}$ hour of air @ 150°C.
- 2) 2 hours of continuous vacuum, during which time the temperature is lowered to 100°C for filling. A vacuum of 30 microns or less is attained at the end of this period.
- 3) Filling under vacuum of about 100 to 300 microns at 100°C.
- 4) Vacuum soak for $1\frac{1}{2}$ hours at 100°C.
- 5) Capacitors removed from tank and immediately sealed.

The impregnant for all capacitors made for a-c tests is 1242 Aroclor manufactured by Monsanto Chemical Co.

Capacitors made for d-c tests are impregnated with various mineral oils or Halowax, depending on the end use of the paper or specific investigation being made.

A-C life testing is done in a circulating air oven at 125°C with voltage stresses in the range of 440 to 1100 volts per mil of paper. D-C life testing is also done in a circulating air oven and usually at 130°C.

The life of a capacitor is the time the capacitor remains under the con-



continuous and constant voltage and temperature conditions before its dielectric fails by a short circuit. These conditions of test are selected at a point where the accelerated life is short enough to give results within a reasonable time, but long enough to be indicative of actual life.

The results obtained by applying the data from these facilities have been very gratifying as may be illustrated by the following graphs. Figure 1 shows the improvement which has been made in the dissipation factor of the low loss grade of capacitor paper by using the results of small trial runs of paper in which controlled process variables were introduced. These variables concerned the degree of purification of the paper stock. Figure 2 illustrates the effect on life caused by the elimination of one minor con-

taminant, lubricating oil.

With the aid of these new facilities, we have been able to improve the quality and performance of our capacitor paper by eliminating sources of contamination, improving processes and controls, and by developing new grades. In the course of this work, we have also gained the experience necessary to shorten the capacitor making processes and to change and improve the techniques used in sampling, winding, assembly, drying, and testing to a point where capacitor results from wound units may be obtained on reels of paper being made each day.

This is only the beginning of a program of development of the dielectric properties of capacitor paper which is expected to result in notable improvement in this product.

right here



LACING CORD

harnessing materials

SLEEVING

complete source

SPIRAL WRAP

stocked in depth

ZIPPER TUBING

ready to go

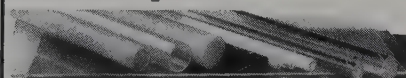
HARNESS BOARD POSTS

Need our catalog



CABLE CLAMPS

or Samples?



PLASTIC ROD, SHEET & TUBE

Write! We'll send!



**illumitronic
engineering**
sunnyvale • california

Tests Show Suitability of Resin-Glass Fiber Armature Bands for Metal-Rolling-Mill Drives

By R. W. Stevens, Insulation Specialist, General Electric Co., Schenectady, N.Y.

Bands built up of metallic wire such as bronze, copper, and steel have been used in the electrical industry for many years to retain the components of rotating machinery against centrifugal forces. On large d-c rotors, such retaining bands have been utilized to hold in place the portion of the winding which projects from the rotor slots so that it won't fly outward during operation. Such bands with many improvements in banding materials, solders, and banding techniques have served well for over 50 years.

In the early 1950's, however, as a result of efforts to utilize the high strength, temperature stability, and inertness of fibrous glass, a new concept in armature banding was developed. In parallel with the introduction of glass fibers was the development of a polyester resin which, in combination with glass, produced a material with the properties desirable for a high-strength banding tape. The resin, on curing, encases each glass thread in a steel-like grip, allowing the use of a unidirectional filament without cross-thread reinforcement. In addition, this resin imparts the properties of limpness, freedom from tack, and handleability desirable for successful application to armatures.

The use of these polyester-glass bands on the armatures of metal-rolling-mill motors has many advantages which contribute to a greater reliability and reduced maintenance.

1. *More uniform distribution of temperature throughout the winding*—because no current can circulate in the resin-glass band, and no thick pad of insulation is needed under the band as was necessary for the metallic bands. Therefore heat may escape to the ventilating air more rapidly. Secondly, no eddy currents can develop in the glass bands, as in metallic bands, to produce self-heating.

2. *Safer operation*—in the event of an

armature coil failure in the end winding, the resin-glass bands have been found to suffer only slight damage but still remain intact. In the case of steel bands, the tremendous heat generated by the fault has melted solder in the steel bands, causing them to be thrown from the rotor, seriously damaging other components of the machine.

3. *Ease of application*—because it is unnecessary to cement each turn of glass tape to its adjacent turn as it is applied or to insulate sections of the bands from adjoining sections to reduce eddy currents, resin-glass bands can be applied more rapidly than metallic bands.

The use of steel sectional bands will be continued on all large, low-speed machines such as blooming-mill motors, because of the convenience of quick removal and replacement of this type of band.

Although, as mentioned previously, no insulation is required between the resin-glass fiber band and the armature coil end windings, a thin, fully cured polyester glass laminate is placed under the band. This laminate prevents the resin in the banding tape from bonding to the polyester resin-glass armor tape on the armature coil, so that the band can be removed if necessary.

Before this new concept in armature banding could be used on large rotating armatures an exhaustive evaluation program was undertaken to prove the reliability of the materials and processes of application.

Let us look briefly at the theory of armature banding. Wire or tape is wound under tension around armatures to produce bands of high hoop stress to resist the centrifugal forces exerted on the end projections of coils. Sufficient numbers of turns are applied at a given tension such that the radial inward component resulting from that tension will always be

greater at the overspeed condition by a generous factor of safety than the radial outward centrifugal force produced by rotation. The coils, supported on their inward surfaces by the structure of the rotor, are compressed between the permanent tension of the band and the underlying support. Should the inward component of force due to the band tension be less than the outward centrifugal force, the coils will lift.

It is extremely important, therefore, that the processes for applying the material and curing be done in a manner which will maintain the required tension.

With this concept in mind the General Electric laboratories have developed techniques to measure the decay of tension in fiber tightly wound on a solid core. Using split steel discs with prestressed bands of resin-glass wrapped on their outer diameter (see figure 1), decay of prestress was studied as a function of application processing and as a function of accelerated heat aging at elevated temperature. Table I indicates the percent of original prestress remaining in bands applied and cured by three differing techniques and emphasizes the need for correct processing when applying the resin-glass fiber bands.

This table also points out, contrary to popular belief, that the resin-glass bands do not shrink and become tighter on curing. The resin does shrink but this manifests itself in becoming more tightly attached to the glass fiber and exerts no force to increase tension.

Table II indicates the excellent retention of prestress even after prolonged aging at temperatures far above the normal operating temperature of the band. In addition, bands prestressed at 95,000 psi, far above normal application prestress, suffered only 10% relaxation after six months

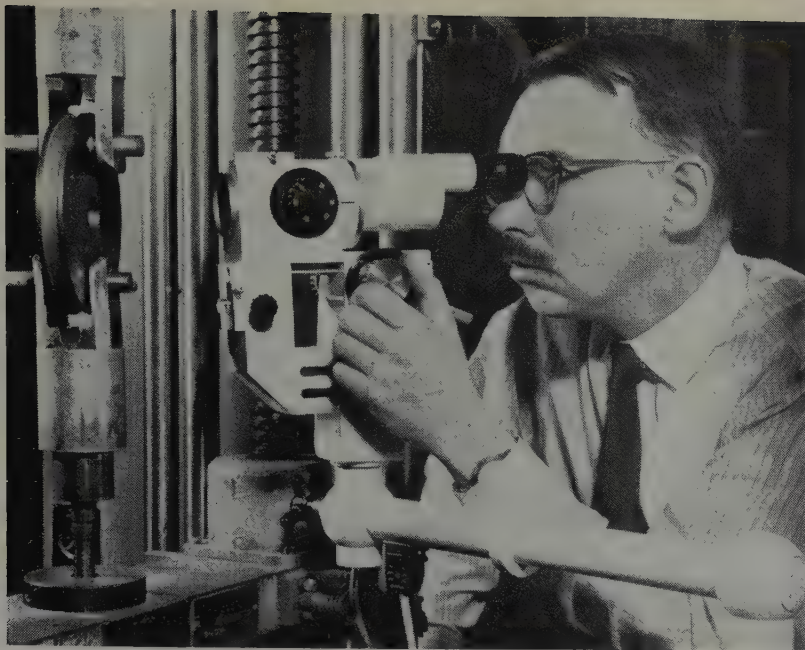


Figure 1, technique for studying decay of tension of resin-glass bands was developed in G-E's General Engineering Laboratory.

Table I

Application Technique	Tape Tension	Calculated Force to Separate Discs	Observed Force to Separate Discs	% Tension Retained
1	185 lb	3700 lb	1380 lb	37% (not acceptable)
2	200 lb	4000 lb	1700 lb	42% (not acceptable)
3	170 lb	3500 lb	3250 lb	92% (adopted)

Table II—Hoop Stress as a Function of Aging Time at 200°C

Hours Aged at 200°C	Force to Balance Hoop Stress	
	Sample 1	Sample 2
0	950 lb	800 lb
2776 (16.5 wks.)	855 lb	800 lb

exposure to 150°C aging.

In addition to the laboratory physical and thermal evaluation of the materials and processes used in the resin-glass bands, several large machines used in our production test area have been banded with this new material. These machines have been in operation for an average of three years during which the bands have been periodically observed and measured. Finally having been assured that the use of resin-glass bands was sound from the standpoint of reliability, units for sale to the customer were produced with this type of banding.

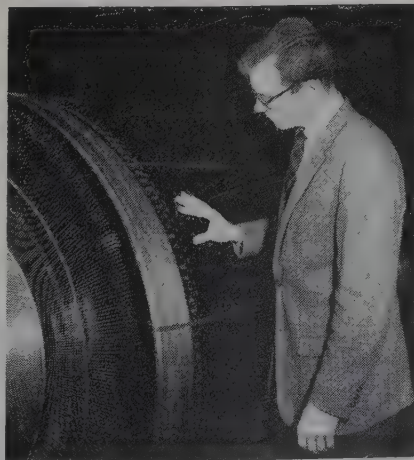


Figure 2, R. W. Stevens checks resin-glass binding bands.

NEW AND
REMARKABLE

PENNTUBE III



SPAGHETTI TUBING and MONOFILAMENT

gives you NEW advantages:

LOWER IN COST
HEAT SEALABLE
TRANSPARENT
FLEXIBLE

PLUS
Fluorocarbon benefits:
EXCELLENT ELECTRICAL PROPERTIES
at high and low temperatures
ZERO MOISTURE ABSORPTION
CHEMICALLY INERT
THERMALLY STABLE
TOUGH • NON-FLAMMABLE

PF Penntube III can solve many process or design problems and replace more expensive and less effective materials. It is ideal as insulation for electrical wire, cable assemblies, for instruments and laboratory use.

PF makes Penntube III in monofilament down to .008" and Spaghetti Tubing in AMS 3648 sizes. Cutting and treatment for adhesion are standard services.



Write, wire or phone
for additional information
on PENNTUBE III

**PENNSYLVANIA
FLUOROCARBON CO., INC.**

1115 N. 38th Street, Philadelphia 4, Pa.
PHONE: EVergreen 6-0603 TWX: PH 252

Print Ins. 20 on Reader Service Card

European Insulation Report

Ed Note: The author of this monthly European report is a well-known insulation expert associated with a large European electrical manufacturer. Although it is necessary that his identity not be revealed at this time, correspondence may be exchanged with him by writing European Editor, Insulation, Box 270, Libertyville, Ill.

Insulating Oils

New Findings on the Properties of Mineral Oils with Regard to the Maintenance of Transformer Oils by P. Stoll and R. Schmid in Schweizer Archiv für angewandte Wissenschaft und Technik, Vol. 26, No. 12, December 1960, pp. 455-477. Original title: "Neue Erkenntnisse über die Eigenschaften der Mineralöle im Hinblick auf die Pflege von Transformatorenölen." Prof. Dr. P. Stoll and Dr. R. Schmid are with Micafil A. G., Zürich, Switzerland.

The paper gives an excellent description of the reasons which make

the traditional methods of oil-preparation though filtering, vacuum-drying and degassing indispensable. The possibilities and methods of regenerating used oil using Fuller's Earth filters and inhibiting additives are also discussed.

As to oil control methods, emphasis is placed on the traditional methods (viscosity, specific gravity, refractive index, aniline point, neutralization number, saponification number, formation of sludge, loss factor, etc.) and on the connection between the various properties. Yet, it appears that the authors attach great importance to infrared spectography in particular, and the many infrared spectra included strongly emphasize the possibilities of this method.

An especially interesting part of the paper is concerned with the conception of an oil preparation and regeneration plant. In the scheme is the plan of a portable plant (see figure 1) which is suitable for the preparation and regeneration of old and new oil

and for drying out complete transformers. The plant is laid out on the following principles:

1. The treatment with Fullers Earth is only successful if the oil is previously dehydrated to show a water content of less than 10 grams per 1000 kg.

2. The Fullers Earth filters are arranged so that the oil molecules can remain as long as possible in the active part. For maximum utilization of the filterway, one then comes automatically to pressure filling.

3. Only highly reactive Fullers Earth should be used, and it is not suitable for use with hydrochloric acid.

Naturally it is necessary that when the aged oil is cleaned, the paper insulation of the transformer should also be cleaned. This is done by repeatedly spraying the paper insulation of the transformer with oil while continuously filtering the oil.

The authors arrive at the conclusion that a regeneration plant is economical when the cleaned oil gives satisfactory test results after 4 to 7 circulations and it is shown from examples that transformer oil regeneration costs approximately 13¢ per kg — depreciation of plant, etc., included.

It is emphasized that regeneration is necessary before a replacement of old oil by new. Without regeneration, the new oil is contaminated at once by the residue left in the paper insulation of the windings, and a suitable regeneration must be carried out again as for a used oil.

On the Drying and Degassing in High Vacuum of Insulating Oils for High Tension Cables by Drs. K. Brinkmann and M. Beyer in the Elektrotechnische Zeitschrift, Part A., Vol. 81, No. 20/21, 26th September 1960, pp. 744-749. Original title: "Ueber die Hochvakuum-Trocknung und -Entgasung von Isolierölen für Höchstspannungskabel." Prof. K. Brinkmann is a director of Continental Electroindustrie Aktiengesellschaft, Düsseldorf, West Germany; Dr. M. Beyer is with the high tension institute of the technical high school in Braunschweig,

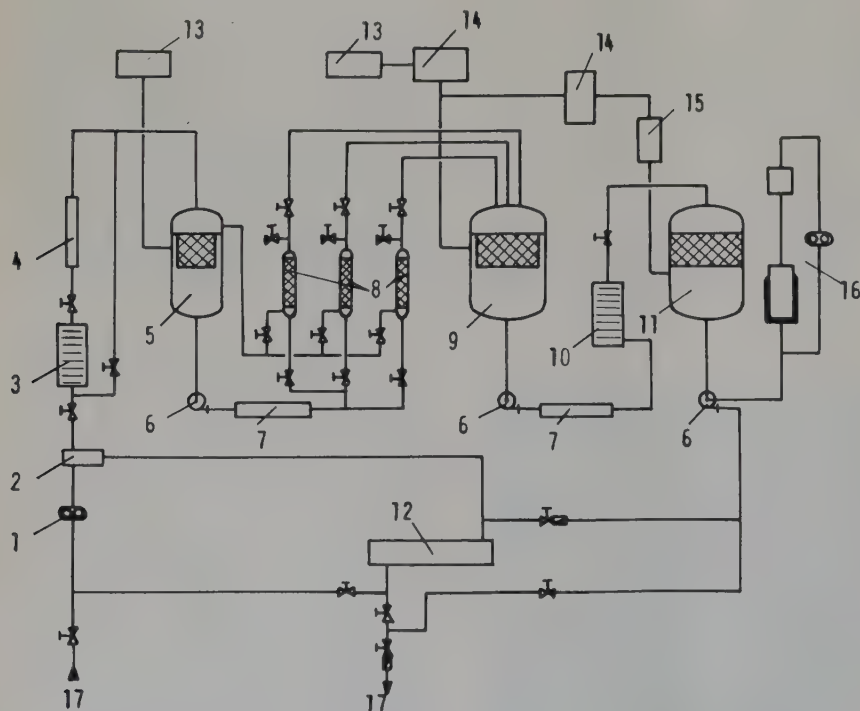
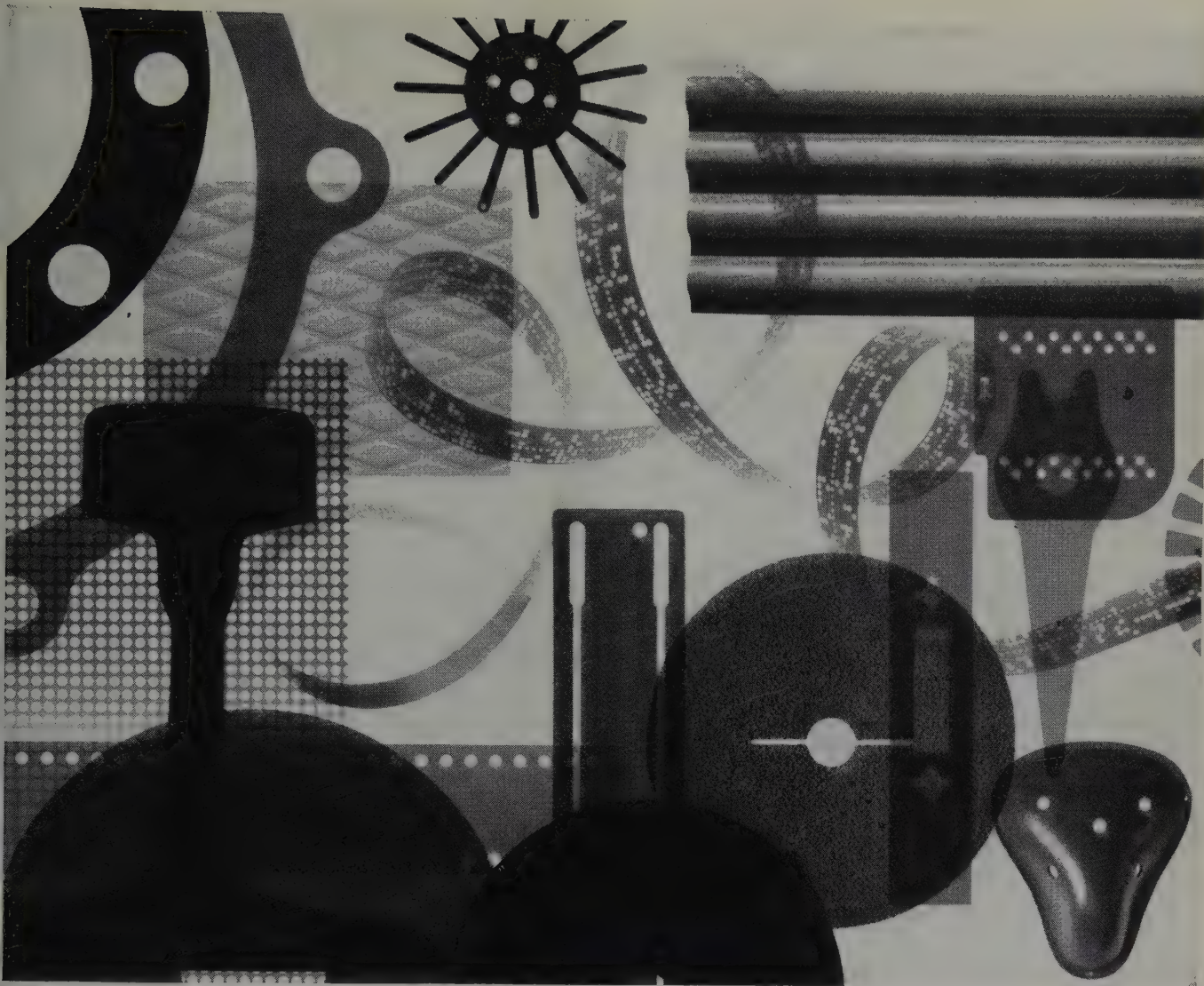


Figure 1, portable plant for preparation and regeneration of transformer insulating oil: 1) feed pump, 2) regulating valve, 3) filter press, 4) cooler, 5) degassing tank—first stage, 6) circulating pump, 7) oil heater—25 kv, 8) Fullers Earth containers, 9) degassing tank—second stage, 10) filter press, 11) degassing tank—third stage, 12) oil heater—120 kv, 13) vacuum pump, 14) Roots pump, 15) condenser, 16) inhibitor installation, 17) Roots pump, 18) condenser.



Consider the many ways this plastic can toughen your product, lighten your problem

National Vulcanized Fibre is one of the most do-more, save-more, get-around materials ever produced. Thousands of jobs well done have established its reputation. Yet there are still other cost-cutting applications to be explored, many that no other plastic can handle.

What is Vulcanized Fibre? A tough, dense cellulosic plastic. As track insulation, thousands of tons of Vulcanized Fibre are now absorbing the steady beating of trains passing over. Has superior arc resistance; high dielectric strength; is class "A" electrical insulation. Low thermal conductivity, high resiliency, great shock and abrasive resistance. Shrugs off oil, gasoline, most solvents. A most un-ordinary plastic. Weighing but half as much as aluminum, Vulcanized Fibre is one of the strongest of materials for its weight.

You can machine, punch, form, deep-draw; combine with rubber, copper, laminated plastic, and other materials. Takes polish, paint, embossing. Consider design and shape . . . you'll find Vulcanized Fibre as motor slot insulation or in intricate forms such as gear assemblies.

There are 16 standard and many special grades, among them "Pyronil", which is fire-resistant. You may well find precisely the properties needed to make your

product a better buy. There's a free sample kit waiting for you at a nearby NVF sales office. Check Sweet's Product Design File 2b/Na for the one nearest you. Or write directly to Dept. D-5, Wilmington, Delaware.

116 Choices: One Source This is the latest count of the different plastics and grades NVF can offer in your search for the *one best material*. Add to this total *the one* special grade that can be developed from scratch to meet your particular need. This full range of materials is backed by complete engineering services . . . from application assistance up to and including the delivery of 100% usable, precision-fabricated parts . . . in any quantity, on time!

Call the NVF Sales Office near you. It's a direct line to single-source help on your current materials problem.



NATIONAL VULCANIZED FIBRE COMPANY
WILMINGTON 99, DELAWARE

In Canada: NATIONAL FIBRE COMPANY OF CANADA, LTD., Toronto 3, Ontario

Print Ins. 21 on Reader Service Card

West Germany.

The authors have the view that the quality of insulating oil required for cables is not attained by the normal degassing and dehydration methods (20-40°C, 5-20 Torr).

By means of comprehensive apparatus, the individual influences of water, gases, and inorganic impurities were investigated. The loss factor, specific insulation resistance, and 50 cycles/sec breakdown voltage were taken as measures of the quality of the oil.

The breakdown strength of the oil is as follows: As supplied 60-80 kv/cm; after vacuum treatment at 5-20 Torr, 330 kv/cm approx. This rising of the breakdown voltage is caused by the extraction of water so that the residual moisture content is less than 1×10^{-6} . The specific insulation resistance also climbs correspondingly from around 10^{12} ohms/cm as supplied up to 5×10^{15} ohms/cm. The loss factor, $\tan \delta$, falls quickly until the residual moisture content drops to 20×10^{-6} ; it then remains steady on further treatment at a value depending on the type of oil and its treatment.

In the paper, it is also shown how $\tan \delta$ is influenced by metallic contamination caused by the oil flowing through oil pumps and pipelines, and it is also shown that, if the oil is allowed to stand after degassing, $\tan \delta$ drops to almost 50% of its former value.

Naturally, this low viscosity oil absorbs moisture very quickly on contact with the atmosphere and loses its outstanding dielectric properties. Two processes are therefore described which allow an almost simultaneous impregnation of the cable insulation after the drying and degassing of the

low viscosity insulating oil so that its better dielectric properties remain constant.

Electrophysical Properties of Common Electrical Insulation Materials Under the Influence of Radiation by K. A. Wodopjanow, B. S. Worroskzow, Dr. G. Potachowa, N. S. Oljskanskaja in *Elektritshestvo* (official Russian electrotechnical journal), Vol. 1960, No. 5, pp. 60-66.

As a result of their investigations, the authors have arrived at the opinion that the change in dielectric losses and insulation resistance of electrical insulating materials under gamma-ray radiation essentially depends on the polarization and the dielectric losses at a given temperature and frequency. Losses arise in some materials owing to dipole motion and relaxation time, neither $\tan \delta$ nor the insulation resistance being changed as a result of radiation. In the case of materials with ohmic losses predominant, $\tan \delta$ and the insulation resistance change. This behavior can be predicted from the dependence of the dielectric constant and $\tan \delta$ on temperature and frequency.

These extensive investigations were made with a betatron (gamma-radiation — 15 mev, 300-1200 Röntgen for 1 minute). The tests were also carried out at different temperatures and in tropical conditions (40°C, 98% relative humidity). The most interesting results of irradiating the most important materials are summarized below:

Polyethylene. A rise in the values of $\tan \delta$ and insulation resistance at lower temperatures, a drop in the values under tropical conditions, and no change at room temperature.

Silicone rubber. The rise of the results in question can be cancelled out by heat treatment. Vulcanizing is accelerated.

Silicone. Properties changed, especially at the higher and lower temperatures.

Molded phenol-formaldehyde. $\tan \delta$ and insulation resistance changed, especially at the higher and lower temperatures. The breakdown strength is unaltered.

Examination and Measurement of Corona by Tests on Insulation, by

W. Widmann in *Electrotechnische Zeitschrift*, part A., Vol. 81, No. 23, 7th November, 1960, pp. 801-807. Original title: Beurteilung und Messung der Korona bei Insulationsprüfungen. Herr W. Widmann is the manager of the high-tension laboratory for insulation testing, AEG, Stuttgart, West Germany.

The author makes a general survey of the effects and aftermath of corona and the methods used for measuring corona. He then proposes a corona cell which he defines as a "standard of corona."

The difference between corona in gaseous voids in a dielectric and corona in a flowing dielectric such as transformer oil must be noted. The charge of the corona causes the destruction during discharges in gaseous voids, but, on the contrary, oil destruction is caused by the power of the corona.

At present, the Schering bridge is extensively used to measure corona. By means of suitable arrangements of the bridge, the losses due to conductance can be separated, in most cases, from those due to corona.

The author discusses corona measuring equipment which can measure either a wide frequency band or, using selectivity, a narrow bandwidth. It is then proposed to introduce a standard corona which has the following properties:

a) The type and shape of the corona impulse must correspond to that of the original object.

b) There must be no interference with the measuring equipment.

c) It should be possible to imitate the effects of different electrode spacings and dielectric constants for various arrangements of the test object.

Figure 2 shows the proposed standard corona cell. The first discharge appears at approximately 2 kv. The electrodes are completely air-tight and it is possible to maintain a practically constant corona intensity for a given voltage.

The author proposes that this standard be built into a sphere which is used for voltage measurement and inserted into the complete object in the places where corona is expected.

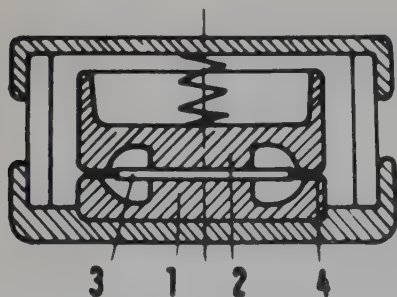


Figure 2, proposed standard corona cell: 1, 2) electrodes, 3) glass plate, 4) condenser.

OW ... SAVE TIME AND MONEY!

... on form-wound coils, busbars, and field coil insulation with G-E Fusa-Fab* semi-cured polyester treated glass cloth and tape. High resin content, (62%), eliminates varnish dips and bakes. Fusa-Fab can be machine wound. It cures without pressure in 15 minutes at 150 C.

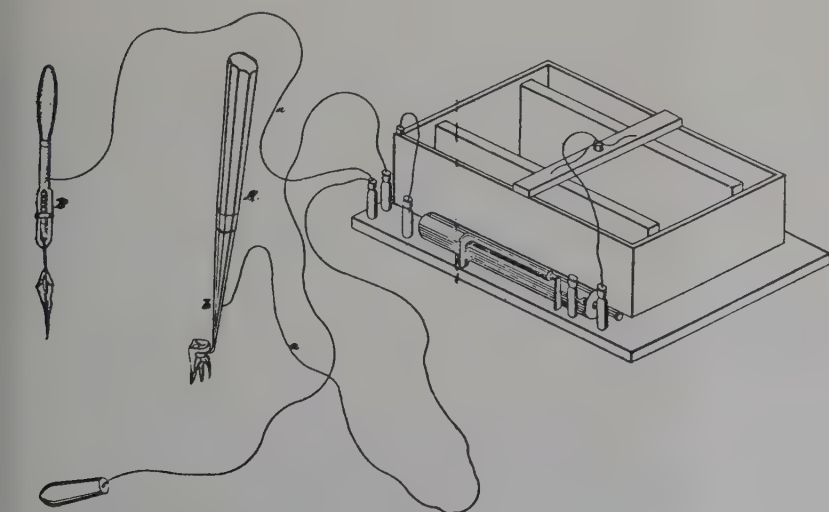


directly and constantly to the internal nerve or dental pulp during the extraction or cutting out of the same.

"The object of my invention is to enable the dentist to extract the whole of the interior nerve without the least pain to the patient, and thus avoid the necessity of drawing such teeth as might be successfully filled with gold or other metal, and thus preserved for a number of years in a state which will give the patient no annoyance or pain, which is not the

working portions of the tooth, I apply the excavator through which the electricity is passing to the decayed cavity and clear away the carious dentine, so as to fully expose the nerve. This being done, I cut out the main body of the nerve without pain to the patient, as the electric current in passing from the end of the excavator is all the time coming in contact with the nerve and producing its deadening effect thereon. I now lay aside the excavator and apply the electric current to the

survives and external decay leading thereto may be filled with gold or any of the preparations used for such purpose, and the tooth saved from further destruction or kept in a perfectly normal or healthy condition like unto any unaffected tooth, no inflammation or sequent ulcerations of the parts resulting therefrom, as follows: the deadening of the nerve by arsenic and other similar preparations, which mostly leave the surrounding parts in an abnormal state."



New Location

The office of our New York sales office for *Insulation* and the *Insulation Directory/Encyclopedia* issue has been moved. The new location is: 1 Rockefeller Plaza, New York 20, N.Y. Our new phone number there is CIRCLE 6-4712.

Other sales and editorial offices have not been changed.

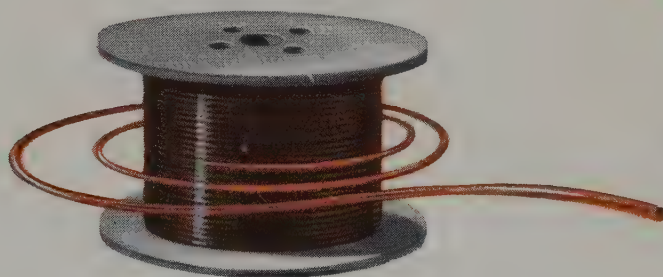
Print Ins. 22 on Reader Service Card for General Electric Co. ad above.

Breakthrough!

PHELPS DODGE

POLY-
Thermaleze

*has replaced six
or more
film wires!*



**Industry's only multi-
purpose magnet wire!**

POLY-THERMALEZE,[®] a Phelps Dodge Applied Research development, is answering a long-awaited need of the electrical equipment industry for a universal magnet wire.

Property for property,
POLY-THERMALEZE®
 matches or exceeds
 all these
 wires!

	Phelps Dodge rating AIEE #57 procedures	Abrasion Resistance Repeated Scrape	Abrasion Resistance Unilateral Scrape	Film Flexibility	Solvent Shock	Solvent Resistance	Resistance to Freon 22	Variable Pressure Cut-thru at 200°C	Constant Pressure Cut-thru at 2000 gm	Heat Shock at 150°C	Dielectric Twist: volts per mil.	Insulation Resistance in megohms after 10 min. water boil
FORMVAR®	105°C	60+	1300	20%-1X	20%-3X OK	Good	Fair	8 lbs.	205°C	20%-3X OK	3000	200,000
NYFORM	105°C	20+	1600	20%-1X	20%-3X OK	Good	—	10 lbs.	230°C	20%-3X OK	2500	100,000
POLY-THERMALEZE	155°C	60+	1400	20%-1X	20%-3X OK	Excellent	Good	30 lbs.	305°C	20%-3X OK	4000	500,000
EPOXY	120°C	20+	1400	20%-1X	20%-3X OK	Fair	Fair	4 lbs.	200°C	20%-3X OK	3000	200,000
NYLEZE®	130°C	30+	1700	20%-1X	20%-3X OK	Good	—	16 lbs.	250°C	20%-3X OK	2500	200,000
TERMALEZE B®	130°C	20+	1500	10%-1X	10%-3X OK	Good	—	16 lbs.	325°C	10%-3X OK 20%-3X Fails	3000	500,000
TERMALEZE F®	155°C	50+	1300	20%-1X	0%-3X OK 10%-3X Fails	Good	—	17 lbs.	290°C	0%-3X OK 10%-3X Fails	3000	500,000

For the first time, **POLY-THERMALEZE®** per-
 its standardization to one all-around film
 within Class F (155C), Class B (130C)
 and Class A (105C) temperature ranges.

Any time your problem is magnet wire,
 consult Phelps Dodge for the quickest, surest answer!



PHELPS DODGE COPPER PRODUCTS
 CORPORATION
 INCA MANUFACTURING DIVISION
 FORT WAYNE, INDIANA

New Publications

Books

Electricity and Electronics, Volume I of a three volume series on *Precision Measurement and Calibration*. 845 pages, \$6. Order National Bureau of Standards Handbook 77 (Vol. I) from the Supt. of Documents, U.S. Government Printing Office, Washington 25, D.C.

The British Miniature Electronic Components and Assemblies Data Annual 1961/62, edited by G. W. A. Dummer and J. MacKenzie Robertson. Covers British miniature components, composite components, miniature printed wiring and potted circuit assemblies current in the year March 1961 to March 1962. Approximately 550 pages, 11" x 8½", \$15. Pergamon Press Inc., 122 East 55th St., New York 22.

Progress in Ceramic Science, Volume 1, edited by Dr. J. E. Burke. Illustrated, 240 pages, 9" x 6", \$10. Pergamon Press Inc., 122 East 55th St., New York 22.

Frequency Modulation Theory—Application to Microwave Links, by J. Fagot and Ph. Magne. (Volume II of an international series of monographs on electronics and instrumentation.) Approximately 500 pages, illustrated, \$12.50. Pergamon Press Inc., 122 East 55th St., New York 22.

Mathematical Handbook for Scientists and Engineers, by Granino A. and Theresa M. Korn. Contains definitions, theorems, and formulas for reference and review. 960 pages, 6" x 9", illustrated, 110 tables, \$20. McGraw-Hill Book Co. Inc., 330 West 42nd St., New York 36.

1960 Research Highlights of the National Bureau of Standards. 65 cents. Supt. of Documents, U. S. Government Printing Office, Washington 25, D.C.

Digest of Literature on Dielectrics, edited by L. J. Frisco and T. D. Callinan. Contains summaries and evaluations of technical advances in the field which were published in 1959. 421 pages, 2,200 references, 8½" x 11",

\$8. National Research Council, Washington 25, D.C.

Soviet Physics—Technical Physics. A translation of the Journal of Technical Physics of the Academy of Sciences of the USSR. Published monthly. Volume 5, Nos. 1-12 covers 1960. \$55. American Institute of Physics, 335 East 45th St., New York 17.

Rome Air Development Center Reliability Notebook—Supplement 1.

Supplement 1 consists of a revision of Section 8—Parts Reliability Factors of the basic volume, the RADC Reliability Notebook. 215 pages, \$3.50. Order PB 161 894-1 from the Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D.C.

EIA Publications

Up-dated registration lists for electron tubes and semiconductor devices have been published by the Joint Electron Devices Engineering Councils (JEDEC) of the Electronic Industries Association and the National Electrical Manufacturers Association. They are available from the EIA Engineering Office, 11 West 42nd St., New York 36.

JEDEC No. 17-2, Electron Tube Registration List for JEDEC Type Numbers Registered Sept. 1, 1960, to Dec. 31, 1960. 25 cents.

JEDEC No. 18-2, Semiconductor Devices Registration List for JEDEC Type Numbers Registered Sept. 1, 1960, to Dec. 31, 1960. 25 cents.

Other new EIA publications include:

EIA Standard 239, Electrical Rating Systems for Electron Tubes. 25 cents.

Guide for Measurement and Reporting of Electronic Equipment Maintainability. \$2.

Maintainability Digest for the Electronics Industry. (Order Maintainability Bulletin No. 1.) \$2.

Electron Tube Types Versus Packaging Classifications. (Order JEDEC Publication No. 20.) \$1.

ASESA Information

The following bulletins merely provide information about action taken by The Armed Services Electro-Standards Agency, Fort Monmouth, N.J. Copies are not yet available.

MIL-C-25/5D, Capacitors, Fixed, Paper-Dielectric, Direct Current (Hermetically Sealed in Metallic Cases), Styles CP63 and CP65. Several changes and additions necessary to correct errors in the printed copies are being incorporated in MIL-C-25/5E which is currently being prepared.

MIL-T-27A, Transformers and Inductors (Audio, Power, and Pulse). D-C resistance tolerance under Electrical Ratings and Electrical properties has been changed from $\pm 5\%$ to $\pm 10\%$, and referencing of mounting studs and terminals from the side of the case have been changed to the centerlines of the case.

MIL-P-642A, Plugs, Telephone. Amendment-3 makes several important changes and additions.

MIL-P-22748, Plastic, Polyethylene and Copolymers, High Density, Molding and Extrusion Material. A new specification.

MIL-C-5B, Capacitors, Fixed, Mica Dielectric. Amendment 3 makes several changes and additions.

MIL-R-18546C, Resistors, Fixed, Wirewound (Power Type, Chassis Mounted) General Specification for. Revision C supersedes MIL-R-18546B (SHIPS) and MIL-R-8781 (USAF) with several changes.

MIL-S-3786A, Switches, Rotary (Circuit Selector, Low Current Capacity). Supersedes MIL-S-3786 with several changes.

MIL-C-17C, Cables, Radio Frequency; Coaxial, Dual Coaxial, Twin Conductor and Twin Lead. MIL-C-17-43B requires a Type I jacket for RG-88/U. MIL-C-17/68A through MIL-C-17/71A specify that the inner conductor of RG-187A/U, RG-188A/U, RG-195A/U, and RG-196A/U be made of annealed copper-covered steel wire.

STEVENS GLASS FABRICS

SUPERIOR IN EVERY WAY

...made in the largest and most completely coordinated plant devoted exclusively to the production of Glass Fabrics... Stevens Fiber Glass is superior because every phase of the manufacturing process is under one roof... under one continuous quality control system.

Research facilities are available for coordinated product development on a confidential basis.

Superior service is assured with balanced inventories of basic fabrics, weights and finishes.

Come to Stevens first for SUPERIOR QUALITY... SUPERIOR SERVICE... for Glass Fabrics... Woven Rovings... Glass Tapes.



WEAVING - Stevens plant, at Slater, South Carolina, utilizes only the most modern weaving equipment available to maintain its high quality standards.



INSPECTION - Every roll - every yard - of glass fabric is carefully inspected to insure its conformance to Stevens high standards.



SHIPMENTS - Stevens own trucking fleet speeds glass fabric shipments to key delivery points throughout the nation.

FINE FABRICS MADE IN AMERICA SINCE 1813

J.P. STEVENS & CO., INC.

INDUSTRIAL GLASS FABRICS DEPARTMENT
Stevens Building, Broadway at 41st Street
New York 36, N. Y. • Oxford 5-1000

People in the News



SPECIAL CABLE CONSTRUCTIONS

- ◆ Solid or stranded copper conductors; tinned—silver plated
- ◆ Teflon or silicone rubber insulation
- ◆ Twisted pairs; multiple conductors
- ◆ Jackets of Nylon, Teflon, fiberglass or silicone rubber
- ◆ Braided metal shielding

These and many other special cable constructions are available to you from the Markel Line of Excellence. Phone, write or wire your specs for a Markel quotation.

L. FRANK **MARKEL** & SONS
SINCE 1922

1 SOURCE for EXCELLENCE in
Insulating Tubings, Sleeveings, and Lead Wire

NORRISTOWN, PENNSYLVANIA
Print Ins. 25 on Reader Service Card

56 Insulation, May, 1961

Robert L. Noble, 66, president and one of the original founders of the Dano Electric Co., Winsted, Conn., died recently.

Samuel A. Ferguson, 44, vice president and general manager, Mountain View (Calif.) Operations, Sylvania Electronic Systems, a division of Sylvania Electric Products Inc., died recently of a malignant tumor. He has been succeeded by *Jesse R. Lien*. In the Electronic Defense Laboratories at Mountain View, *Dr. Victor Twersky* has been promoted from head of research to senior scientist, *Col. Francis N. Miller* (USA, ret.) has been appointed head of the field engineering section, and *Norbert J. Gamara* has been named manager of the antenna research and development department. Also at Mountain View, *Melvin E. Lowe* has been appointed manager of the Reconnaissance Systems Laboratory. In Warren, Pa., the Parts Div. has appointed the following: *Joseph W. Parks Jr.*, field sales manager; *Wilson L. Bentz*, district sales manager, Southeast; *Richard S. Kelly*, district sales manager, metropolitan New York; and *Richard A. Wilson*, salesman, Indianapolis. In Buffalo, N. Y., *James H. Murphy* has been named manager of the technical liaison department.

Willard F. Bates has been appointed director of manufacturing for the new Data Recorders Div., Consolidated Electrodynamics Corp., a subsidiary of Bell & Howell Co. Other appointments in the division include that of *Burt W. Cobb* as factory manager, *Edward P. Fleischer* as manager of materiel, and *John P. Mitchell* as manager of manufacturing engineering.

New senior sales specialist in Monsanto Chemical Company's Inorganic Chemicals Div. is *George M. MacLeod*, who will locate on the West Coast.

Appointments in the Silicone Products Dept., General Electric Co., Waterford, N. Y., include: *John H. Blomshield*, manager of facilities de-

sign and construction; *Thomas H. Fitzgerald*, manager of the East Central Sales District; *J. William Houtz*, East Central District sales representative (Cleveland); and *Charles A. Berridge*, sales representative (Downey, Calif.).

John L. Altekruze has been named to head a new aerospace department in the Goodyear Aircraft Corp., Akron, Ohio.

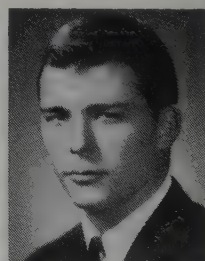
Donald T. Blizzard and *Norbert Cvengros* have been appointed assistant engineers in the control department, Allis-Chalmers Manufacturing Co. *Harold C. Dusek* and *Orland J. Thompson* have been assigned to similar posts in the thermal power and nuclear power departments, respectively.

Charles S. Stryker has been appointed sales manager, and *William F. Turner* named director of technical services for the Plastics Div., Reichhold Chemicals Inc., White Plains, N. Y.

The newly-created post of product manager at Tempron Inc., Reseda, Calif., has been filled by *William Draganchuk*, formerly with General Cable Co.



W. Draganchuk



H. White

Harold F. White has been appointed wire product manager of the Special Products Div., Sprague Electric Co., North Adams, Mass. *Dr. Jerrold R. Zacharias*, nuclear scientist, has been elected to the board of directors of Sprague to succeed *Dr. Jerome B. Wiesner*, who recently resigned to be Special Assistant for Science and Technology to *President Kennedy*.

John L. Wilson, formerly with Hercules Powder Co., has been appointed by Taylor Fibre Co., Norristown, Pa.,



FOR WIRE AND CABLE APPLICATIONS...

A complete line of quality Fiber Glass Yarn from one source—Johns-Manville

J-M offers ALL the types of fiber glass yarn you need for wire and cable insulation...in packages designed for maximum production on all wire and cable manufacturing equipment. *But there's more to the J-M story*—product quality second to none, thanks to J-M's exclusive and superior method of drawing exceptionally uniform filaments for fiber glass yarn used in electrical insulation. Also, J-M's highly skilled technicians work constantly to develop new and improved products for wire and cable manufacturers.

For high-quality fiber glass yarn or for technical help, call the nearest J-M textile specialist. Written inquiries may be sent to J. B. Jobe, Vice-President, Johns-Manville, Box 14, New York 16, New York, or to J-M Textile Glass Sales, 1810 Madison Avenue, Toledo 1, Ohio. In Canada: Port Credit, Ontario. Cable address: Johnmanvil.

JOHNS-MANVILLE
FIBER GLASS



Print Ins. 26 on Reader Service Card

as manager of its new filament winding division.



J. L. Wilson



J. P. Smith

J. P. Smith Jr. has joined the Ortho Filter Corp., a division of Ortho Industries Inc., Paterson, N. J., as a senior engineer.

Personnel changes in the Atlas Powder Co., Wilmington, Del., include appointment of Dr. Walter H. C. Rueggeberg to the new post of director of research and development, naming of William C. Griffin and Dr. George O. Rudkin Jr. as associate directors of chemical product development, and appointment of Drs. John D. Brandner and John W. LeMaistre as associate directors of chemical research. F. Faxon Ogden has been named research and development planning advisor.

Lester Lipset has been promoted to manager of the quality-control department at Narda Microwave Corp., Mineola, L. I., N. Y.

In the Computer Div., Philco Corp., Willow Grove, Pa., C. R. Lambert has been named chief engineer-manufacturing, and Robert S. Senator has been appointed manager-Systems Engineering Laboratory.

Arno Adhesive Tapes Inc., Michigan City, Ind., has named William A. Donahue industrial sales manager and appointed Jack Schneider to cover the Westchester County, New York, and New England sales territory.

S. E. Yeaton has been appointed assistant vice president, General Cable Corp.

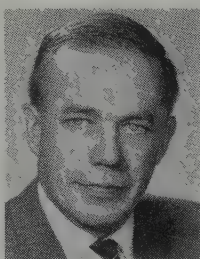
J. C. Stansel has been appointed manager of Continental-Diamond Fibre Corporation's Newark, Del., laminated plastics plant.

William W. Smith has been named manager of engineering and development, Nickel-Alkaline Battery Div., The Electric Storage Battery Co., West Orange, N. J., to succeed J. Donald Moulton, who has retired.

Warren J. Rowley has joined the Clark-Schwebel Fiber Glass Corp., New York City, as vice president in charge of sales in the Midwest.

General Phillips W. Smith (USAF, ret.) president of Jack & Heintz, Cleveland, a division of The Siegler Corp., Los Angeles, has been named a vice president of Siegler.

Atherton Noyes Jr. has joined the General Radio Co., West Concord, Mass., as an engineering consultant. General Radio's engineering vice president, Ivan G. Easton, has been appointed to an advisory committee on calibration and measurement services by the National Bureau of Standards.



A. Noyes



I. Easton

F. J. Stokes Corp., Philadelphia, has added Neil Huizing to its Union, N. J., sales staff which serves metropolitan New York and northern New Jersey.

R. S. Bowditch has been appointed chief engineer of the Electronics Div., Statham Instruments Inc., Los Angeles.

Mobay Chemical Co., Pittsburgh, Pa., has appointed William C. Auld manager of purchasing, a new post.

Raymond H. Heller, general manager of Robertshaw-Fulton's aeronautical and Instrument Div., Richmond, Va., has been elected an assistant vice president.

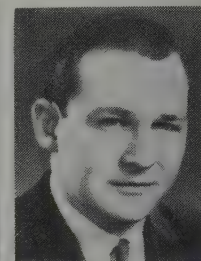
At Haveg Industries Inc., Taunton, Mass., D. M. Pixley has been appointed market specialist for hermetic seals made from "Havelex" material in addition to his present duties as research and development engineer.

John Ross has been named manager of research and development department, Metals & Controls Inc., Attleboro, Mass., a division of Texas Instruments Inc.

At Shawinigan Resins Corp., Springfield, Mass., Robert P. Carlson

has transferred from the sales department to adhesives technical service.

Joseph I. McCormick and John T. Hastings have been promoted to product managers in the industrial sales division of The Dobeckmun Co., Cleveland, Ohio, a division of Dow Chemical Co.



J. I. McCormick J. T. Hastings

R. Bruce Baptie has been appointed sales manager of the Carwin Co., North Haven, Conn.

New appointments in the sales department of Escambia Chemical Corp., New York City, include that of J. M. Martin, sales manager for vinyl resins; J. T. Carley, sales representative for vinyl resins in New England and metropolitan New York; and Miss Lois Follansbee, sales correspondent for vinyl resins and industrial chemicals.

V. Reed Manning has joined Simplex Wire & Cable Co., Cambridge, Mass., as assistant to the vice president—engineering. He will be responsible for communication and electronic systems.

R. E. Carlson, St. Paul, Minn., has been appointed sales representative in Minnesota by the Cincinnati Development & Mfg. Co., Cincinnati, Ohio.

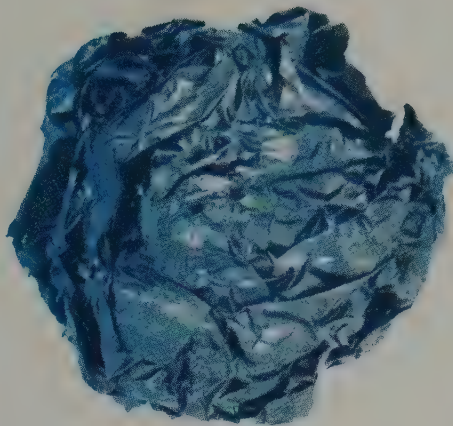
John E. Povolny, production superintendent at the Minnesota Mining and Manufacturing Co. magnetic products plant in Hutchinson, Minn., has been named plant manager for the new 3M magnetic products plant being built at Freehold, N. J.

New Midwest regional sales manager for the Union Carbide Plastics Co., division of Union Carbide Corp., New York City, is Howard L. Burpo Jr. He will be assisted in the Chicago office by Harold A. Holz and William G. Westergan, assistant regional managers. New technical sales representatives in the Midwest are Fredric M. Smith (Chicago) and William R. Neely (Kansas City, Mo.).

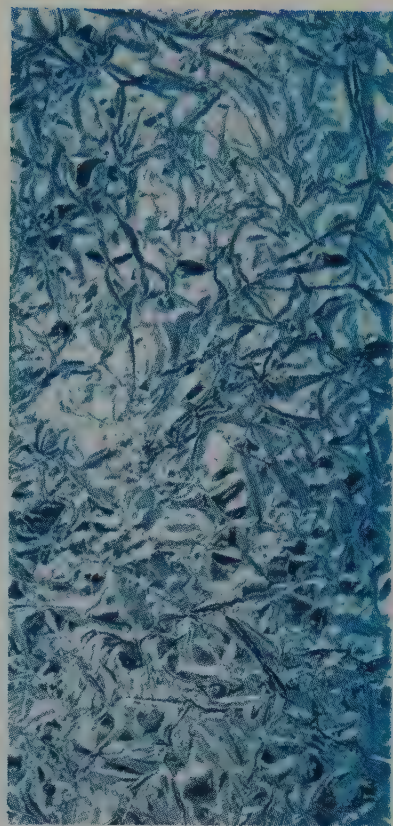
What's News in Enjay Resins...



Buton 200 resins on aluminum foil



Same foil crumpled



Foil straightened out after crumpling

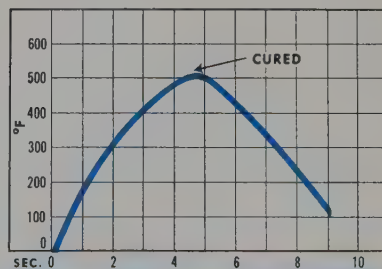
BUTON[®] Resins offer excellent adhesion on aluminum

As you can see above, Buton resins provide excellent adhesion on aluminum. Tests have shown that Buton-based coatings adhere to aluminum foil even after crumpling. This adhesion, plus the high gloss and complete colorability of Buton resins, opens up many opportunities in aluminum coatings. In addition, Buton resins offer:

- *Wide cure range—air dry to high speed, high temperature cures (see chart at right)*
- *Excellent chemical and water resistance*
- *Good electrical properties.*

Economical—Buton resins are high in bulk and can give you more coating gallonage per resin pound. For more information, contact Enjay at 15 W. 51st St., New York 19, N. Y.

CURE RATE OF BUTON 200 RESIN ON FOIL



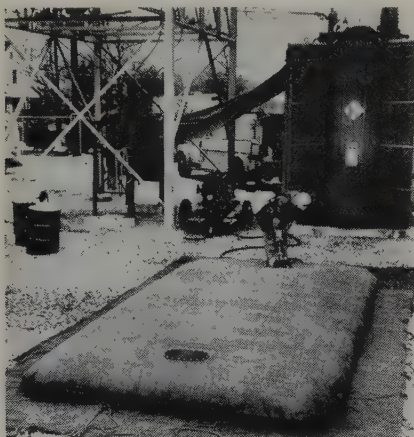
EXCITING NEW PRODUCTS THROUGH PETRO-CHEMISTRY

ENJAY CHEMICAL COMPANY

A DIVISION OF HUMBLE OIL & REFINING COMPANY
Print Ins. 27 on Reader Service Card

Store Transformer Oil In Fabric Tanks During Maintenance

Power companies are utilizing large collapsible tanks made of rubberized fabric in place of steel drums or metal tanks to store oil during periods of repair and routine overhaul of oil-bearing substation transformers and circuit breakers. The 3,000 gallon "Pillow Tanks," manufactured by the Goodyear Tire & Rubber Co., can be compactly rolled and carried in the back of a pickup truck.



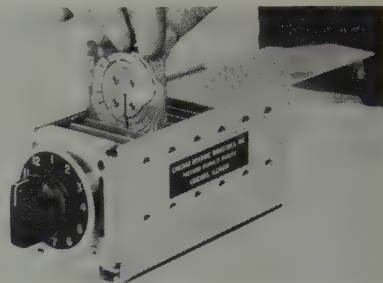
Workmen merely roll out a flat Pillow Tank, pump the oil into it, do the necessary repair work, and pump the oil back into the transformer or circuit-breaker. The use of these tanks reportedly cuts by almost two-thirds the time previously required.

More Accurate Radio Frequency Broadcast

The world's most accurate yardstick of radio frequency is now broadcast from Sunset Canyon, about 20 miles west of Boulder, Colo. Transmission on the very low frequency of 20 kilocycles provides a standard frequency broadcast one hundred times more accurate than previous broadcasts. (The lowest frequencies picked up by a home radio are about 560 kilocycles.) Within their range these signals will substantially increase the accuracy of the National Bureau of Standards' standard frequency broadcasts. The signals may reach as far as Hawaii and are the first step toward eventually providing world-wide broadcasts.

Removable Printed Circuit Wafer

Removable printed circuit wafers reportedly permit quick, error-proof servicing of this new rotary selector switch. Wafers lift out for instant re-



placement, with no soldering, disassembling, or wire removal necessary. The corrosion-resistant wafers are etched from a copper clad laminated plastic grade (Formica XXXP-36) which is translucent, easily cold-punched, and offers high insulation resistance. The wafers plug into individual receptacles. The switches, available for manual, solenoid, or motor-driven operation, are made by Chicago Dynamic Industries Inc., Precision Products Div., Chicago.



Few materials can come even close to natural mica's resistance to blistering hot temperatures, a feature which is important wherever long life or unusual operating conditions are important. Space-saving thinness and unusual electrical insulating properties are added bonuses. And when you need mica, make sure you specify precision fabrication by Huse-Liberty. Typical uses include vacuum tube micas, supports, resistance cards, washers, transistor mountings, microwave windows, tubes, and other critical electrical/electronic work. The reader service card number below should be used to obtain rush information on mica.



THE HUSE-LIBERTY MICA COMPANY
Lynnfield St., Peabody, Mass., Jefferson 1-7100

Print Ins. 57 on Reader Service Card

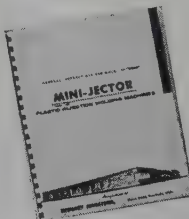
DO YOU AVOID PLASTIC INJECTION MOLDING because you think it's too complicated, expensive?

It is easier than you think with a MINI-JECTOR®! No need to invest heavily in costly machinery, expensive tooling, or skilled personnel. Hundreds of leading companies have found MINI-JECTORS the low-cost answer to making their own precision plastic items and saved thousands of dollars. The machine: MINI-JECTOR (starts under \$1,000); mold blanks low as \$29.50; no previous experience necessary to operate. Molds perfect parts, including those involving inserts or loose cores, in all thermoplastics including Nylon (1/8 oz. to 2 oz.).

New catalog shows how simple plastic injection molding can be with the MINI-JECTOR. Shows many models to fit your special needs . . . at big savings. Write today.



NEWBURY INDUSTRIES, INC.
Box 58, Newbury, Ohio



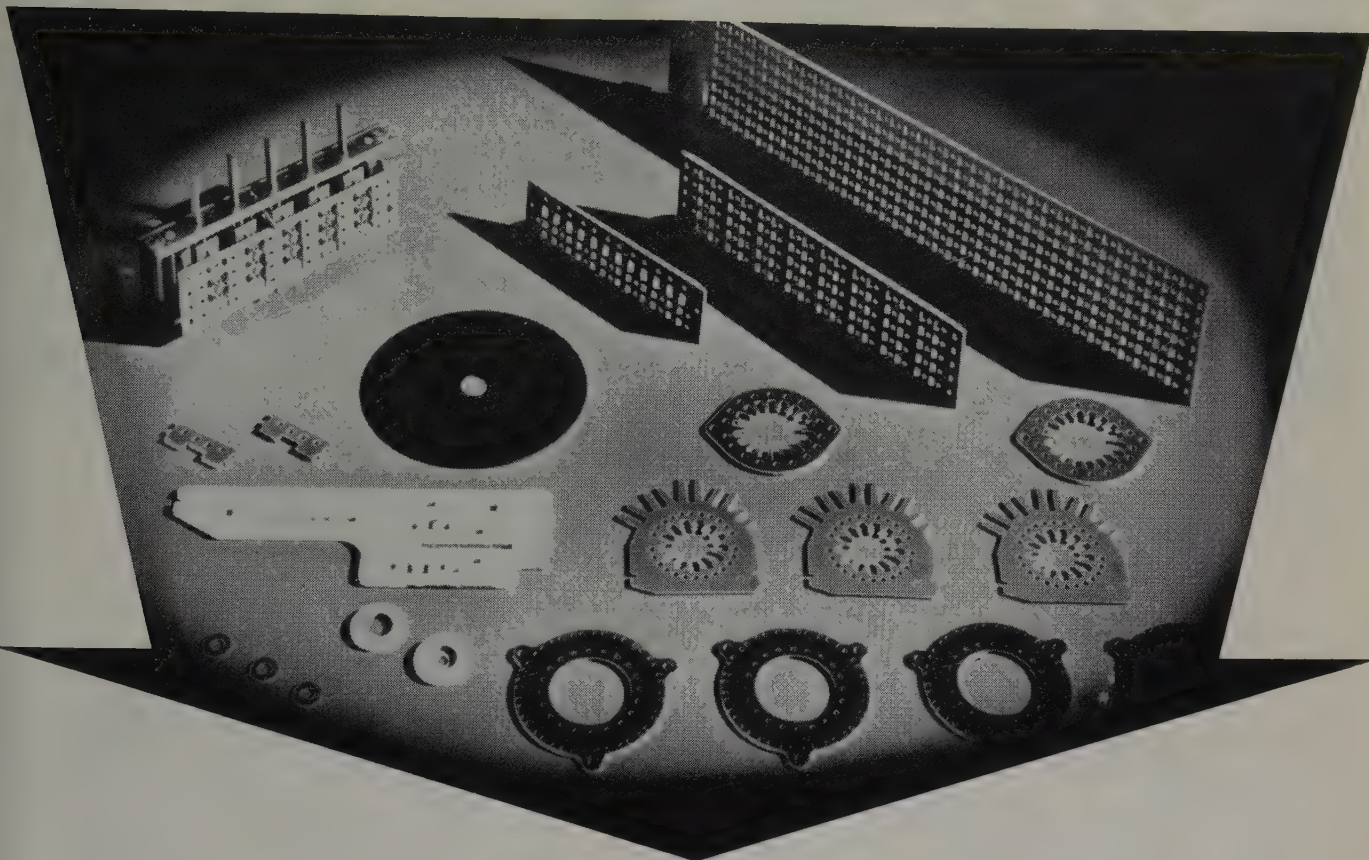
NEWBURY INDUSTRIES, INC. For convenience clip coupon to your letterhead and mail
Box 58, Newbury, Ohio

Please send me your new free catalog.

Name _____
Company _____
Address _____
City _____ State _____

Print Ins. 58 on Reader Service Card

What's different about specifying and buying fabricated parts like these from Richardson



A "GUNG HO"* ATTITUDE

There *are* beneficial differences when you buy from the Richardson salesman. He represents a company geared and manned by experienced personnel *"working harmoniously" to provide job shop attention and service to your specific electrical or electronic needs. The differences continue with emphasis on clear customer communications. He is trained to tell you effectively about Richardson's two fabricating plants, and discuss intelligently the many different manufactured grades of laminated Insurok® rods, tubes, sheets, and fabricated parts. He has case history samples to share with you in discussing electrical insulation that can cut your cost and improve equipment performance.

In turn, the Richardson man clearly presents your electrical needs immediately to our plants, assuring accurate

information as to what you want in fabricated part performance, delivery and competitive prices.

In addition, you get better fabricated electrical parts from Richardson because of our undivided responsibility from the original manufactured material through the finished piece. The job-shop-service policy is backed up with substantial production facilities and a careful quality control system.

Your order will be produced by skilled men working together in harmony and getting your job done just right with a minimum of cost. The Marines call it *Gung Ho*. It comes when a company is specialized, experienced and versatile. Call the Richardson salesman today and put this attitude to work for you.

Write Dept. 13 for free technical data

THE RICHARDSON COMPANY

Sales Offices In Principal Cities

2693 LAKE STREET, MELROSE PARK, ILLINOIS

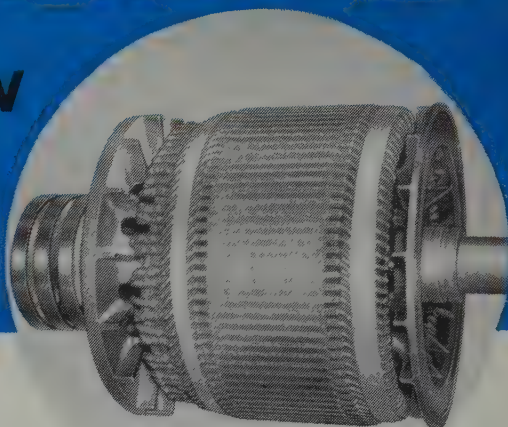
Print Ins. 28 on Reader Service Card

Laminated
Fabricated
and
Molded
Plastics

TREVARNO

VEC-O-TEX

**Something BRAND NEW
in Fiberglass Armature
Banding Tape . . .**



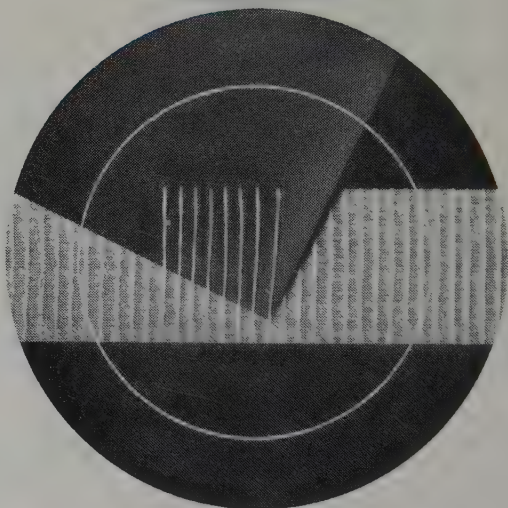
CROSS-REINFORCED • NON-WOVEN

**You get these EXCLUSIVE Time-Saving,
Money-Saving, In-Shop Advantages:**

1. ULTRA HIGH HOOP AND TENSILE STRENGTH
2. ULTRA HIGH CROSS TENSILE STRENGTH
3. MARKED REDUCTION IN TENDENCY TO SPLIT DURING APPLICATION
4. MARKED REDUCTION IN USE OF EDGE RESTRAINTS
5. CURED BANDS WON'T CRACK
6. SUPERIOR SURFACE FINISH
7. PRECISE WIDTH AND THICKNESS CONTROL
8. LESS MATERIAL DOES A BETTER JOB IN LESS TIME

AND, VEC-O-TEX IS COMPETITIVELY PRICED!

INVESTIGATE VEC-O-TEX TODAY!



CONTACT the Distributor Nearest You . . .

OKLAHOMA CITY, OKLAHOMA
BUTTS ELECTRICAL SUPPLY COMPANY
101 North Pennsylvania
Telephone: CE 6-3011

NEW YORK, NEW YORK
BROWNELL ELECTRICAL INSULATION
85 Tenth Avenue
Telephone: WA 4-6000

CAMBRIDGE, MASSACHUSETTS
BROWNELL ELECTRICAL INSULATION
270 Vassar Street
Telephone: UN 4-7500

ATLANTA, GEORGIA
BROWNELL ELECTRICAL INSULATION
690 Murphy Avenue S.W.
Telephone: PL 5-1681

ORLANDO, FLORIDA
BROWNELL ELECTRICAL INSULATION
307 27th Street
Telephone: GA 4-5634

SAN FRANCISCO, CALIFORNIA
ELECTRICAL SPECIALTY CO.
158 Eleventh Street
Telephone: HE 1-8450

SEATTLE, WASHINGTON
ELECTRICAL SPECIALTY CO.
2442 First Avenue, South
Telephone: MU 2-3434

LOS ANGELES, CALIFORNIA
ELECTRICAL SPECIALTY CO.
2820 East 12th Street
Telephone: AN 9-9511

DENVER, COLORADO
ELECTRICAL SPECIALTY CO.
2026 Arapahoe Street
Telephone: CH 4-4588

PHOENIX, ARIZONA
ELECTRICAL SPECIALTY CO.
P. O. Box 232
Telephone: AL 2-2107

PORTLAND, OREGON
ELECTRICAL SPECIALTY CO.
1822 Northwest 25th Avenue
Telephone: CA 7-3601

ST. LOUIS, MISSOURI
F. R. HEARN CO.
Room 105
931 Watson Industrial Park
Telephone: WO 1-6257

MINNEAPOLIS, MINNESOTA
D. A. SCHULTZ COMPANY
801 Southeast 8th Street
Telephone: FE 9-7701

CHICAGO, ILLINOIS
SPECIAL ELECTRIC CO., INC.
1440 N. Halsted Street
Telephone: WH 4-1061

MILWAUKEE, WISCONSIN
SPECIAL ELECTRIC CO., INC.
3116 West Cherry Street
Telephone: DI 2-6960

CLEVELAND, OHIO
R. A. STAFF COMPANY
1213 West Third Street
Telephone: MA 1-4063

TREVARNO

Dept. IS-61

**Visit Our Booth No. 126 At The EASA Show . . .
June 11-14 . . . Jack Tar Hotel, San Francisco**

VEC-O-TEX
NON-WOVEN FABRICS

Print Ins. 29 on Reader Service Card

**FOR ADDITIONAL INFORMATION Write to
COAST MANUFACTURING AND SUPPLY CO.
P. O. Box 71, Livermore, California
A Leader in Industrial Glass Fabrics and Finishes
since 1947 • Established 1867 • Plants are located in
Livermore, California, and Seguin, Texas.**

Letters to the Editor

More Comment on Epoxy Resin Article

"I read the article (January 1961 issue of *Insulation*) on New Developments in Epoxy Resins—Part 2 by Lee and Neville with considerable interest and in general found it to be well presented and a thorough compilation of curing agents for epoxy resins. It should prove of particular interest to the curious but uninitiated as an introduction to epoxide chemistry. The section of 'mutually exclusive properties' is noteworthy in emphasizing a problem which every epoxy formulator recognizes and with which he must constantly contend.

"There are a few technical aspects of this article which are puzzling. The

choice of an epoxide derived from a vinyl ether to illustrate the curing reactions of an epoxide appears poor since it is not a good representative of the more important, commercially produced epoxy resins. A vinyl ether epoxide would also be expected to react differently than indicated by the products in figures 5 and 6, i.e., attack would be expected at the α carbon atom rather than the β carbon atom*.

"The reaction shown in figure 6 is incorrect since to obtain the product shown, phthalic acid (and not phthalic anhydride), water, or a glycol derivative of the epoxide would be required to produce this product.

"In figure 4 the statement is made that—"Theoretical calculations indi-

cate each catalyst molecule can catalyze or initiate a chain of polymerization of 10-30 molecules of resin,' True catalysts don't initiate reactions, they just alter the reaction rate. From a practical standpoint one finds in epoxy resin compositions a certain catalyst concentration which is preferred as a compromise between ultimate properties and cure rate that is frequently of the order suggested by the article and perhaps this was the intended interpretation."

—C. Cialdella, Director, Research & Development, Hysol Corp., Olean, N.Y.

*Mechanisms of Epoxide Reactions by Parker and Isaacs, Chemical Reviews, 59, 737-799, (1959).

Supervisory Position

For Materials Engineer

(ELECTRICAL INSULATION)

This position involves working with industry, standardization groups, designers, and laboratories in the development of dielectrics for use in connection with modern Naval electrical and electronic equipment.

The applicant must be familiar with polymers and inorganic materials; and he must have broad experience in materials, purchase specifications, and insulation systems. He will be the Bureau Consultant on dielectric problems.

The starting salary for this position ranges from \$10,635 to \$13,510. The excellent benefits of career Civil Service are included. Write Mr. Lee Probst, Civilian Personnel Division, Code 263R.

**DEPARTMENT OF THE NAVY
BUREAU OF SHIPS
Washington 25, D. C.**



202
212
253
290

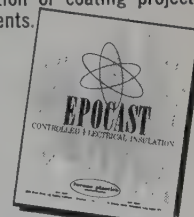
= SUM TOTAL

**an EPOCAST EPOXY RESIN FORMULA
for any ELECTRICAL INSULATION PROBLEM!**

More than 30 different formulas are now in stock to solve your electrical insulation problems. Whether it be an extreme environmental condition or a normal impregnation, encapsulation or coating project, there's a Furane epoxy resin to fit your requirements.

**WRITE NOW FOR
FREE ELECTRICAL PROPERTIES
CHART!**

**furane plastics
INCORPORATED**



WEST COAST/4516 Brazil Street, Los Angeles, California, CHapman 5-1151
EAST COAST/42 Chasner Street, Hempstead, L.I., N.Y., IVanhoe 3-6246

Print Ins. 30 on Reader Service Card

Association News

New Name for AES

The members of the Aircraft Electrical Society have approved the change in the name of the society to Aerospace Electrical Society.



The new name is in line with the broadened scope of AES interests and activities which include missiles and space vehicles as well as manned aircraft.

Carlyle Smith, senior electronic systems engineer, Lockheed Aircraft Corp., Burbank, Calif., has been elected president for 1961 to succeed James D. Andrew, Space Technology Laboratories Inc.

John F. Christi Jr. has been elected vice president and James E. Johns, treasurer. Both men are from Lockheed Missile and Space Division, Van Nuys. Robert H. Jerome, Missile and Space Systems Engineering Dept., Douglas Aircraft Co., is secretary.

Edgar M. Lewis of Douglas was appointed director of the 1961 Aircraft Electrical Society Display, presented annually at the Pan Pacific Auditorium in Los Angeles. Lewis will be assisted by Frank Norris of Northrop, and A. A. Waldron of Lockheed.

Electronic PA's Elect Weingast President

The P.A.'s Inc., purchasing agents of the radio, television, and electronics industries, have elected Al Weingast, Director of Purchasing, Precision Apparatus Co., as president for 1961.

Also elected were the following officers: Vice President, Milton Brody, Mohawk Business Machines Corp.; Recording Secretary, Louis Lucci, Republic Electronic Industries; Corresponding Secretary, E. J. Trimboli, Telechrome Mfg. Co.; Treasurer, A. Schnlederman, Olympic Radio & Television.

Elected directors of the organization were: Bernard Loew, Adams Labs; Paul Reneau, Magnetic Ampli-

fiers; Abe Weissman, Marken Machine; Sam Wolfson and Arnold Sutta, Emerson Radio & Phonograph.

Chase, Others Nominated For 1961-62 AIEE Offices

The nomination of Warren H. Chase, Ohio Bell Telephone Co., to be 1961-62 president of the American Institute of Electrical Engineers, and the nomination of 10 vice presidents and four directors have been announced. The election will be by mail ballot and results will be announced at the Summer General Meeting at Ithaca, N.Y., in June.

Vice presidents who were nominated are: Thomas E. Marburger, Baltimore, Md., Gas & Electric Co.; Benjamin V. Martin, Westinghouse Electric Corp., Charlotte, N.C.; Warren B. Boast, Iowa State U., Ames, Ia.; Charles R. Day, Sacramento, Calif., Municipal Utility District; J. Prescott Skillen, Hamilton, Ont.; Leslie J. Weed, Boston, Mass., Edison Co.; and Alva A. Johnson, Westinghouse Electric Corp., East Pittsburgh, Pa. Nominated to be technical vice presidents were: Charles E. Dean, Hazeltine Research Corp., Little Neck, N.Y.; Lee R. Larson, Martin Co., Denver, Colo.; and J. H. Kinghorn, American Electric Power Service Corp., New York, N.Y.

Nominated to be directors were: Bradley Cozzens, Water and Power Department, City of Los Angeles; Walter F. Denkhaus, Bell Telephone Co. of Pennsylvania, Pittsburgh; John W. Dais, Southern Bell Telephone & Telegraph Co., Atlanta, Ga.; and Lynn C. Holmes, Stromberg-Carlson Co., Rochester, N.Y.

W. R. Clark, Leed & Northrup Co., Philadelphia, was re-nominated to be treasurer.

AIEE To Sponsor First Electrical Engineering Exposition, Jan. 29-Feb. 2

The first national Electrical Engineering Exposition sponsored by the American Institute of Electrical Engineers will be held Jan. 29 through Feb. 2, 1962, in the New York Coliseum in conjunction with the

Institute's annual Winter General Meeting.

Technical sessions held in conjunction with the exposition will meet in the Coliseum and in the Hotel Statler which will serve as headquarters for the joint event.

Schumacher New EIA Staff Engineer

J. Howard Schumacher Jr., former staff engineer for the Society of Motion Picture and Television Engineers, has joined the Electronic Industries Association's Engineering Department as staff engineer.

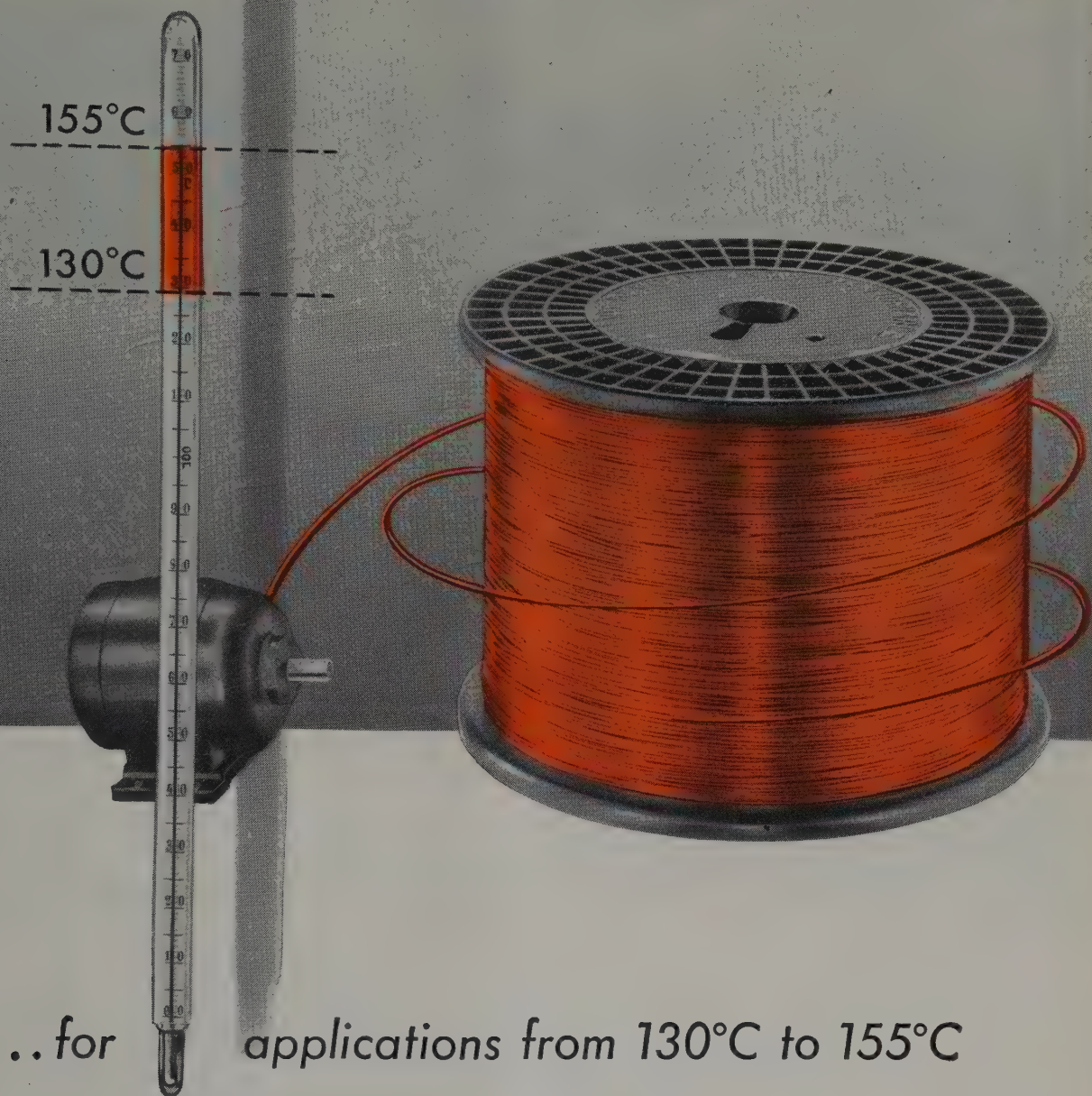
Schumacher will serve as engineer for EIA's Parts Division at the association's engineering offices in New York City.

Committee Heads Named For 1961 WESCON Events

Appointments to head committee planning for the 1961 Western Electronic Show and Convention to be held August 22-25 in San Francisco include the following: Technical Program—E. W. Herold of Varian Associates, chairman, and L. G. Clarke of Stanford Research Institute, vice-chairman; Facilities—Robert Craig of Hanson Laboratory, Stanford University, chairman, and H. M. Meyer of Stanford Research Institute, vice-chairman; Field Trips—Richard J. Reynolds of Hewlett-Packard Co., chairman, and Robert E. Miller of Applied Electronics, Stanford University, vice-chairman; Women's Activities—Mrs. Bernard M. Oliver of Los Altos Hills, chairman, and Mrs. Norman H. Moore of Atherton, vice-chairman; All-Industry Banquet—John S. McCullough of Litton Industries Inc., chairman, and Cortlandt Van Rensselaer of Hewlett-Packard Co., vice-chairman; Future Engineers Show—Jack L. Melchor, chairman, and Alan T. Waterman of Applied Electronics, Stanford University, vice-chairman; Hospitality—John A. Chartz of Dalmo Victor Co., and Donald B. Harris of Stanford Research Institute, co-chairmen.

Show committee heads include: Exhibits—Jack Silhavy of Varian As-

Beldtherm* MAGNET WIRE



..for applications from 130°C to 155°C

Beldtherm is a polyester film-coated magnet wire with excellent thermal stability.

It is recommended for temperature ratings of 130°C to 155°C—depending upon application, a most important point.

LARGE MOTORS Beldtherm is designed for use in stator windings operating at hottest spot temperatures

Other Belden Magnet Wire: Beldenamel*, oleoresinous • Beldsol*, polyurethane-nylon • Beldure*, polyurethane • Beldbond*, polyurethane-bonding agent • Celenamel*, cellulose acetate • Formvar, vinyl acetal • Nylclad*, vinyl acetal-nylon • Epoxy

of 130°C. This temperature may be exceeded provided there is minimum winding and forming abuse, and factors such as radii of coil bends, wire turn cross-overs and pressure between turns are favorable.

TRANSFORMERS Beldtherm, with other suitable material in the insulation system, is suitable for dry type transformers operating at temperatures up to 155°C.

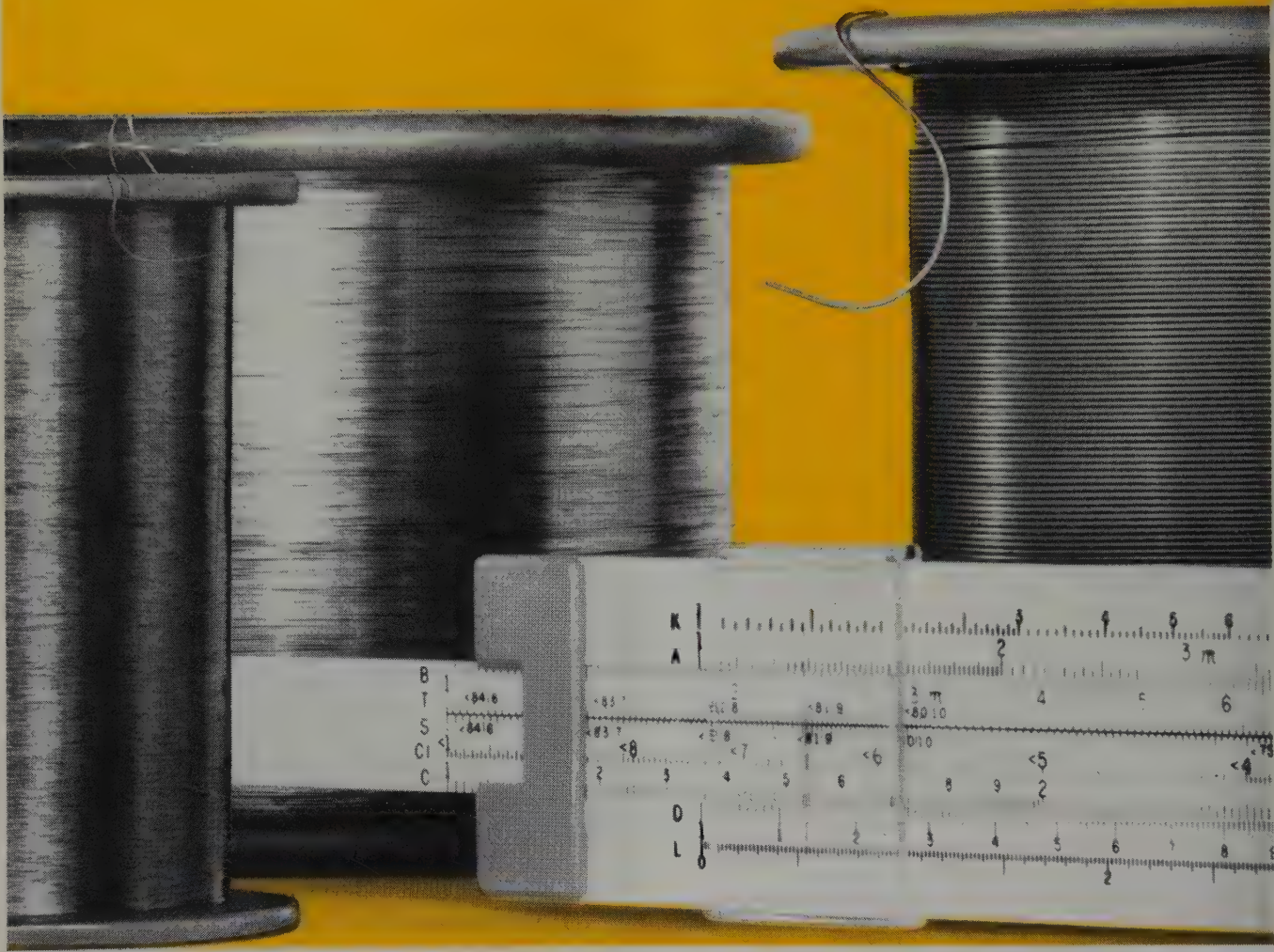
*Belden Trademark
Reg. U.S. Pat. Off.



**one wire source for everything
electrical and electronic**

lead wire • power supply cords • cord sets • portable cordage • electronic wire • control cables • automotive replacement wire and cable • aircraft wire

SYLVANIA MAKES ALL THREE—ALLOY, CLAD AND PLATED WIRE



One way to conserve engineering time —get an unbiased recommendation on wire from Sylvania

Rapid changes in high-temperature equipment plus the continued evolution in components mean this: it doesn't pay to get mired down by noncreative engineering details. Example: which wire to use to meet conductivity needs in corrosive or oxidizing atmospheres?

To make the most of your engineering time, call on *Sylvania* to help you with wire specs. Sylvania knows wire—and the particular advantages of each kind. Of all major manufacturers, only Sylvania makes all three

types of bare wire—alloy, clad and plated. They're available in a complete range of sizes—.002" to .250". Each retains optimum characteristics up to recommended operating temperatures.

You know that a Sylvania recommendation will be objective, based on your needs, and not limited by what the supplier can supply. Full details—plus time saving help—are yours when you write Sylvania Electric Products Inc., Parts Division, Warren, Pennsylvania.

SYLVANIA

Subsidiary of **GENERAL TELEPHONE & ELECTRONICS**



Print Ins. 32 on Reader Service Card

sociates, chairman, and Berkley J. Baker of Litton Industries, vice-chairman; Visitors' Service—W. A. Melchior of Eichorn & Melchior Inc., chairman, and Norman P. Hiestand of Varian Associates, vice-chairman; Registration—Robert E. Johnston of Jennings Radio Manufacturing Corp., chairman, and Fred J. Mackenzie of Stanford Research Institute, vice-chairman; Cocktail Party—Emmet G. Cameron of Varian Associates, chairman, and Glenn A. Walters of Dalmo Victor Co., vice-chairman; Distributor-Representative Conference—Elvin Feige of Elmar Electronics, chairman; and Charles N. Meyer of Meyer and Ross Co., vice-chairman; Industrial Design Competition—Carl J. Clement Jr. of Hewlett-Packard Co., chairman; and J. W. Stringer of International Business Machines Corp., vice-chairman.

Heading Public Relations are Peter N. Sherrill of Hewlett-Packard Co., chairman, and Charles Elkind of IBM, vice-chairman.

Prospective authors of papers to be presented in the technical sessions are asked to send 100-200 word abstracts and 500-1000 word summaries for committee use by May 1. Submissions are to be directed to the attention of E. W. Herold, WESCON, 701 Welch Road, Palo Alto. Notification of acceptance or rejection will be made by June 1.

Hodges, Tyson To Speak at Manufacturing Chemists' Meeting

Secretary of Commerce Luther H. Hodges and Robert C. Tyson, chairman of the Finance committee of United States Steel Corp., will be the principal speakers at the 89th annual meeting of the Manufacturing Chemists' Association, Inc.

Approximately 800 executives from some 180 chemical companies will attend the meeting at The Greenbrier, White Sulphur Springs, W. Va., June 8-10.

Computer Conference May 9-11

More than 2,500 are expected to attend the Western Joint Computer Conference in Los Angeles May 9-11. The conference is sponsored by the National Joint Computer Committee, representing the Institute of Radio

Engineers, the American Institute of Electrical Engineers, and the Association for Computing Machinery.

Technical phases of the conference at the Ambassador Hotel will consist of approximately 70 technical papers by 87 authors.

Among the \$3 million worth of products and equipment to be exhibited by 55 firms are some significant new developments.

Speakers at the conference are Thomas Watson, Jr., president of International Business Machines Corp., who will deliver the keynote address Tuesday, May 9; Dr. Morris Rubinoff, chairman, National Joint Computer Committee, and Dr. Simon Ramo, executive vice president, Thompson Ramo Wooldridge Inc., who will address the Wednesday, May 10, luncheon.

Field trips and a special program of activities for women round out the conference schedule.

Fees, to members of sponsoring organizations, \$6; non-members, \$10; and students, \$2.

Exhibits will be open noon-6 pm, May 9; 10 am-noon and 2-9 pm, May 10; and 10 am-5:30 pm, May 11.

Electronic Components Conference In San Francisco May 2-4

The 1961 Electronic Components Conference will be held May 2-4 in the Jack Tar Hotel, San Francisco. The program will consist of 4 to 5 three hour non-parallel sessions of 4 to 6 papers each.

Two large luncheons are planned. Dr. William Shockley has been asked to speak at one.

Papers are strictly technical and will present either new components and their impact on the future or new techniques which make new components possible. Subjects include (tentative): high voltage components including HV epoxy potted devices and insulation, transformers, switches, bushings, materials, fast d-c fuses, non-destructive HV testing for ultimate failure determination; relays and control circuits including HV vacuum relays for 100 cycles per second keying; semiconductors and devices including Hall effect devices; component testing and reliability; new thermoelectric devices such as

solar powered vacuum types and power sources including isotopic heat sources; micro-miniaturized components and circuit considerations; high temperature capacitors, thin film resistors and other basic components with new capabilities or characteristics; and space components and their new requirements.

Committee chairmen are as follows: General Chairman—Hugh C. Ross, Jennings Radio Mfg. Corp.; Local Arrangements Chairman—Carlton J. Daiss, Anaconda Wire and Cable; Technical Program Chairman—William F. Main, Lockheed Aircraft Corp.; Publicity Chairman—Berkley Baker, Litton Industries; Publications Chairman—Don F. Hamm, Jennings Radio Mfg. Corp.; and Finance Chairman—Roderick W. Neibauer, Jennings Radio Mfg. Corp.

NEMA Plans Western Conference

The National Electrical Manufacturers Association will hold its first Western Conference at the Biltmore Hotel, Los Angeles, on June 8 and 9. Arrangements will be under the direction of co-chairmen A. Arval Morris, Electra Motors Inc., and Raymond M. Waggoner, Hubbard and Co.

Preliminary plans call for starting the conference with a luncheon on June 8 to which all sales allies of electrical manufacturers will be invited. Included will be electrical distributors, contractors, utilities, appliance dealers, and other branches of the electrical industry.

A general meeting is planned for the first afternoon. Subjects discussed will include World Market for Electrical Products, Research and Development, Effects of Imports on the Electrical Industry, and Business Trends Today and Tomorrow. The opening day's sessions will close with a reception and buffet supper for all.

The manufacturers will meet June 9 to review NEMA operations, discuss the growing interest in the Far West, and to devote time and study to safety regulations and product standards as they affect Western manufacturers specifically and the electrical industry generally. The conference will close with a luncheon at which NEMA members will evaluate the sessions

and consider plans for future Western meetings.

Plans also are being made for several group meetings, including special sessions for manufacturers of electric house heating equipment, lighting equipment, and appliances. These meetings are planned for June 7 and the morning of June 8.

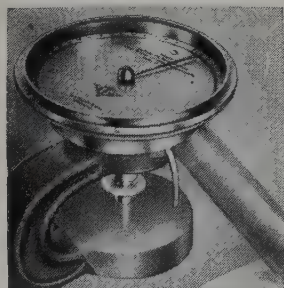
**WESCON Industrial Design
Competition Deadline is May 12**

Deadline for entries in the Third Annual Industrial Design Award Competition to be held in connection with the 1961 Western Electronic Show and Convention at San Francisco's Cow Palace next August 22-25, is midnight on Friday, May 12.

Photographs of components, instruments, systems, and other electronic products which show evidence of original industrial design effort are suitable entries.

Submissions must be products of WESCON exhibitors, members of the Western Electronic Manufacturers Association, or companies exhibiting in booths of authorized representatives.

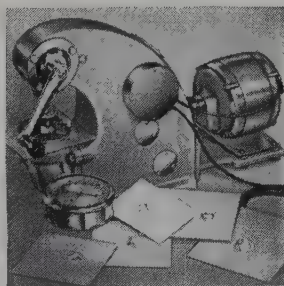
**This Thickness Gauge
Measures Strip or Sheet Stock
In 10/1000ths of an Inch**



Cady
10/1000
Micrometer
Carbide
Tipped
Anvils
Available

Portable and other models also available

Cady
Automatic
Burst
Tester
for
Papers
& Boards



CADYTEST INSTRUMENTS
Register Thickness, Burst
Strength and Basis Weight.
Write for Brochure.

E. J. CADY & COMPANY

682 N. Harlem Avenue, River Forest, Illinois

Print Ins. 33 on Reader Service Card

Still other conditions of acceptance are: products in the competition must have been marketed prior to this May 12 and must not have received WESCON Industrial Design awards previously.

**News of SPE Professional Group on
Plastics in Electrical Insulation**

New officers elected at the annual business meeting of the Professional Activities Group on Plastics in Electrical Insulation, Society of Plastics Engineers, Inc., are A. F. Zavist, General Electric Co., chairman; Leonard S. Buchoff, Electro Tec Corp., vice chairman; and George Chadwick, Speer Carbon Co., secretary.

Elected to the Executive Committee for a term ending in 1964 were Dr. Richard Black, Westinghouse Electric Corp.; Henry Hirsch, General Precision Lab.; and Alex Javitz, Conover-Mast Publications.

L. Buchoff was appointed chairman of an Encapsulation Workshop to be held about May, 1962. Tentative functions suggested were talks on specific areas, demonstrations of encapsulating procedures, and panel discussions. A location was not decided upon.

It was also announced that PAGPEI is sponsoring a new SPE book on "Processing of Thermosetting Resins," to be edited by Walter Gammel Sr.

At a meeting of the Executive Committee, it was decided to sponsor a panel discussion on "Defining Tomorrow's Requirements for Electrical Insulation" in the 1962 Annual Technical Conference of SPE. This will be in addition to the usual half-day session on "Plastics in Electrical Insulation," and will include both users and suppliers.

Also, two task groups were set up. One, under the direction of John Hull, Hull Corp., will endeavor to establish standard properties lists to aid resin formulators and users. The other, under Dr. J. Weschler, Ciba Products Corp., will study the possible preparation of an abstracting magazine.

**ASA Standards Conference
In Chicago June 1-2**

Problems confronting industry in the field of standardization and its application will be discussed at the

15th annual spring meeting of the Company Member Conference of the American Standards Association June 1-2 in Chicago.

Participation at the CMC meeting and its discussions is open to all organizations. Registration blanks and program information may be obtained by writing the ASA, 10 East 40th St., New York 16.

**AIEE District Meeting
At Hartford May 17**

Connecticut's Governor, John Dempsey, will address the noon luncheon opening the three day North Eastern District Meeting of the American Institute of Electrical Engineers, May 17-19 at the Statler Hilton Hotel, Hartford, Conn. The District includes all the New England States. Eight hundred are expected to attend.

**National Telemetry Conference
In Chicago May 22-24**

Theme of the 1961 National Telemetry Conference, which will be held May 22-24 at the Sheraton Towers Hotel, Chicago, is "Science and Education in Telemetry." The conference is sponsored by the American Institute of Electrical Engineers, The American Rocket Society, the Institute of Aero-Space Sciences, the Institute of Radio Engineers and the Instrument Society of America.

Program chairman is Jack Becker, AC Spark Plug Div., General Motors Corp., Milwaukee, Wis.

**Paper on Epoxy Molds in Aerospace
Electronics Conference, May 8-10**

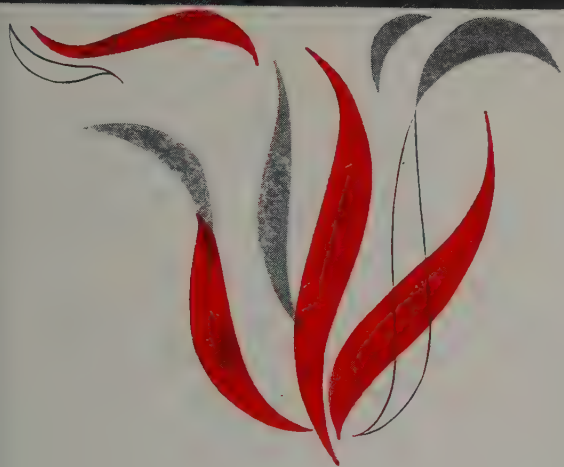
Among the approximately 90 papers to be presented at the National Aerospace Electronics Conference in Dayton, Ohio, May 8-10, is one on "Epoxy Resin Molds for Encapsulating Electronic Circuitry Into Modules," by John J. Tallent, General Electric Co., Utica, N.Y.

Activities will be held in the Biltmore and the Miami-Pick hotels.

**Plastics Distributors Group
Looks for New Members**

The United Plastics Distributors Association has begun an active drive for new members. Inquiries should be directed to UPDA president, August Metz, Commercial Plastics & Supply Corp., 119 9th St., Pittsburgh, Pa.

For the first
time phenolic
XXXPC laminates
with...



both
FLAME RETARDANCE
and
COLD PUNCHABILITY

New Resinox 495 Varnish makes it possible for the first time to produce phenolic laminates with both flame retardance and excellent cold punching characteristics. Paper-based laminates impregnated with Resinox 495 meet the electrical, physical, and mechanical requirements of NEMA standards for XXXP and XXXPC copper-clad laminates—yet they cost far less than other laminates with equivalent properties.

Laminates made with Resinox 495 are especially recommended for printed circuits used for commercial radio and TV applications, and as copper-clad laminates for electronic computers and military applications, or for any other application where flame retardant laminates are desirable or mandatory. Use coupon below for additional data, and list of leading laminators now supplying laminates made with Resinox 495.

RESINOX: REG. U. S. PAT. OFF.



MONSANTO INITIATOR IN **PLASTICS**

Print Ins. 34 on Reader Service Card

MONSANTO CHEMICAL COMPANY, Plastics Division
Room 808, Springfield 2, Mass.

Please send me technical data bulletin on Resinox 495, also list of laminators supplying laminates made with it.

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

Industry News

Digests of technical literature in the electronics and other fields are provided by *Technical Aid Service Inc.*, Columbus, Ohio.

Hammond Organ Co., Chicago, has acquired *Gibbs Manufacturing & Research Corp.*, Janesville, Wis., electronics firm.

Specialty Electronics Development Corp., Syosset, N. Y., manufacturer of electronic equipment, has started construction of a 70,000 sq ft plant in Flushing, N. Y.

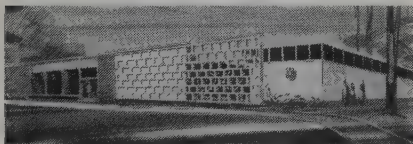
Two Minneapolis plastics firms, *Booker & Wallestad Inc.*, and *Thermotech Plastics Inc.*, have merged. New name is *Thermotech Industries Inc.*

PRL Electronics Inc., Rahway, N. J., has appointed *W. A. Brown and Associates*, Alexandria, Va., as sales representative for its electronic power supplies and test equipment in Delaware, Maryland, the District of Columbia, and Virginia.

Telex, Inc., Twin Cities electronics firm, has acquired *Lumen Inc.*, Joliet, Ill., manufacturer of amplifiers and controls.

Fleming Industries Inc., Torrance, Calif., is a new firm in the electronic ordnance field.

Ultrasonic Industries Inc., has moved to a new 18,000 sq ft facility



in Engineers Hill, Plainview, L. I., N. Y.

Construction on a new million-dollar, 35,000 sq ft plant in Riverton,



N. J., has been started by *Temperature Engineering Corp.*

Plant space has been doubled by *Chemplast Inc.*, East Newark, N. J., producer of "Teflon" products.

A new South Atlantic district sales office has been established in Greensboro, N. C., by the *Laminated Prod-*

ucts Dept., *General Electric Co.*, to market its "Textolite" industrial plastic laminates.

A new regional sales office and warehouse has been established at Linden, N. J., by *Dayton Industrial Products Co.*, Melrose Park, Ill.

Oak Manufacturing Co., Crystal Lake, Ill., electrical/electronic components manufacturer, has purchased for cash the *McCoy Electronics Co.*, Mt. Holly Springs, Pa., producer of quartz crystals and filters.

Regal Plastic Supply Co., Englewood, Colo., has been named a fabricator for *Formica Corp.* (Cincinnati, Ohio) laminated plastics.

The *Hoover Co.*, North Canton, Ohio, electrical appliance manufacturer, plans to build a new 47,500 sq ft factory costing over \$2-million at the North Canton plant.

Paragon Electric Co., Two Rivers, Wis., time control manufacturer, has become a subsidiary of the *American Machine & Foundry Co.* New name is *Paragon Electric Co. Inc.*

Liberty Electronics Corp., Inglewood, Calif., has been licensed by *Cannon Electric Co.*, Los Angeles, to manufacture Cannon connectors.

Southern Electric Sales Co., Dallas, Texas, has been appointed a distributor of electrical insulating varnishes by *Schenectady Varnish Co.*, Schenectady, N. Y.

Insulation Systems, Pittsburgh, is the first specialty insulation distributor named by *Westinghouse Electric Corporation's Micarta Division* in a proposed nation-wide system.

Other new insulation materials distributors named by *Westinghouse Electric Corporation's Micarta Div.*, Trafford, Pa., are *Special Electrical Co.*, Milwaukee and Chicago, and *Smith of Philadelphia Inc.*, Philadelphia.

Trent Inc., Philadelphia, Pa., has appointed *Stolley & Orlebeke* to service its electrically heated industrial equipment in parts of Iowa, Wisconsin, Indiana, and Illinois.

Burnell & Co. Inc., Pelham, New York, manufacturer of electronic filter networks and related devices, has

acquired *Gray & Kuhn Inc.*, Westbury, N.Y., manufacturer of delay lines, for cash from the *IMC Magnetics Corp.*

Tri-Point Plastics Inc., Albertson, Long Island, N.Y. has changed its name to *Tri-Point Industries Inc.*

Headquarters for the newly created *Components and Controls Div.*, *Telex Inc.*, has been established at the company's corporate office in Minneapolis, Minn.

McLean Engineering Laboratories, Princeton, N.J., has completed a new wing which adds 7,000 sq ft of pro-



duction area to the existing 25,000 sq ft. McLean makes electronic cooling and ventilating equipment.

Pennsylvania Fluorocarbon Co., Philadelphia, Pa., has named the *Edwards Sales Agency*, St. Louis, Mo., to represent its tubing and other insulating materials in that area.

Approval of the acquisition by merger of *Kupfrian Manufacturing Corp.*, Binghamton, N.Y., has been announced by *Robinson Technical Products Inc.*

Shipley Co. Inc., of Wellesley, Mass., manufacturer of copper and tin products for electronics, has opened a new West Coast sales office in Los Angeles.

The new *O. E. M. Div. of Robins Industries Corp.*, Flushing, N.Y., recording equipment manufacturer, has been expanded to offer design, manufacturing, and packaging services for new consumer and industrial products to other firms.

The *Electronics Div. of Chance Vought Corp.*, Arlington, Tex., has transferred its Reliability Group from the Engineering Dept. to the Quality Assurance Branch to form a new Reliability and Quality Assurance Branch.

Insulation Manufacturers Corp., Chicago, has been named to represent electrical insulation materials produced by *Rogers Corp.*, Rogers, Conn.

FREE!

WITH EACH 66' ROLL OF

No. 7 SLIPKNOT PLASTIC TAPE

the **NEW** **FLiP-n-CuT** Pat. Pending **INSTANT TAPE DISPENSER**

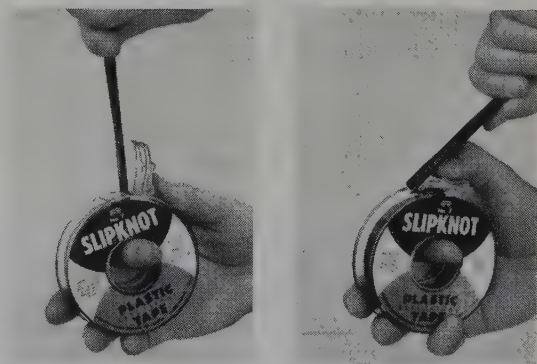
your favorite
plastic electrical tape
now handier than ever!

Protects the tape • Keeps tape clean
Dispenses quickly • Cuts without effort
Convenient — hangs on your belt
Tape easily removed for hard-to-get-at splices
Saves tape — eliminates waste
Starts instantly — no fumbling for the end

Send for a sample
on your letterhead



EASY OPERATION SAVES TIME, TAPE AND TEMPER



PLYMOUTH RUBBER COMPANY, INC.

QUALITY SINCE 1896

CANTON, MASSACHUSETTS

New Materials and Components

For further information on these products print the item number on the Reader Service Inquiry Card on the back cover. Fill out and mail the card—no postage is required. Insulation will immediately forward your inquiry to the manufacturers concerned so that they can send you more information promptly.

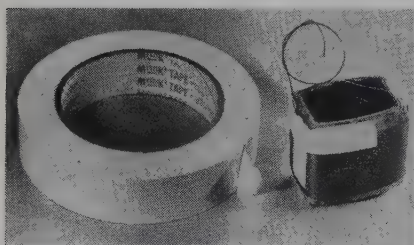
High-Strength Molding Plastic

A new high-strength plastic, trademarked "Celcon," is made by a new chemical process and is classified chemically as an acetal co-polymer. In addition to inherent strength and stability, qualities featured include hardness, stiffness, dimensional stability, light weight, and resistance to abrasion and environmental attack. Field tests reportedly show that Celcon has particularly favorable qualities for economical injection molding into products of both simple and intricate designs and can be extruded and blow molded. Field tests are also said to prove that Celcon can carry heavy loads over long periods of time at high temperatures. Resistance to attack by a wide range of chemicals, including alkalis, is another advantage claimed. Typical markets for Celcon are in business machines, communications equipment, appliances, and others. Celanese Corp. of America, 180 Madison Ave., New York 16.

Print No. Ins. 100 on Reader Service Card

Quick-Cure Thermosetting Tape For Class B Operation

A new thermosetting glass cloth tape is said to cut curing time substantially. Mystik brand No. 7020 tape features a pressure-sensitive thermosetting resin adhesive that cures in 1/2 hr at 350°F. Other features reported are high tack, high



initial adhesion, and excellent resistance to solvents, abrasion, aging, and chemicals. The new tape is designed for class "B" operating temperatures. It may be used in motor construction and repair, and in the manufacture of coils, relays, solenoids, transformers, and other electrical and electronic equipment. Mystik Adhesive Products Inc., 2635 N. Kildare Ave., Chicago 39.

Print No. Ins. 101 on Reader Service Card

Low Temperature Jacketing Material Meets Military Specifications

A new low temperature vinyl jacketing material is designed to meet military specifications JAN-C-17C, MIL-C-915A, and MIL-C-2194D. Compound No. 312 is stated to have good flexibility, excellent retention of elongation after aging, exceptionally smooth surface, and outstanding low temperature characteristics. The Blane Corp., Canton, Mass.

Print No. Ins. 102 on Reader Service Card

Polypropylene for High Temperatures

A new "Escon" polypropylene grade is said to be tailored to give superior performance for extended periods at elevated temperatures. Identified as Escon 125 LTHA (long-term, heat-aging) molding grade, the material is especially recommended for applications in which molded parts are subjected to repetitive, long-term heat exposure, such as backs for television sets, radio cabinets, under-the-hood automotive parts, cable connectors, lighting fixtures, and appliance covers and parts. Price is 46¢/lb in 20,000-lb lots. Properties reported include melting point of 335°F and melt index of 5.5 at 230°F. Test specimens have withstood more than three months of oxidative aging at 300°F, it is stated, and at 250°F specimens have shown no evidence of failure after more than six months. Processing stability of the new grade is claimed to be excellent. Room 1122, Enjay Chemical Co., 15 W. 51st St., New York 19.

Print No. Ins. 103 on Reader Service Card

Paper/Phenolic Laminate Features Cold Punching

A new resin system has been developed for use in a new paper base, phenolic laminate grade that provides exceptional cold punching characteristics. "Insurok" T-755 reportedly has

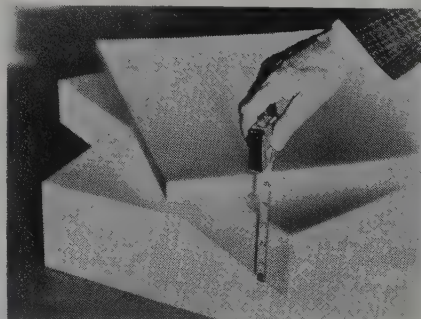


stable punching properties over a wide range of low temperatures, unusually long shelf life, high solvent resistance, and good reproducibility from shipment to shipment. In unclad or copper-clad sheets, electrical and mechanical properties are claimed to be much better than regular XXXPC standards. It is said to be ideal for printed circuits, electrical and electronic components, and other parts requiring excellent electrical properties. It is also used as cold punch material for terminal boards, instruments, and appliance component parts. Technical data available. The Richardson Co., 2724 Lake St., Melrose Park, Ill.

Print No. Ins. 104 on Reader Service Card

Large 'Teflon' Sheets

Sheet forms of Teflon TFE-fluorocarbon resin up to 8" thick and 25" square are now available. The sheets are designed to provide fabricating savings and new design possibilities



THERE ARE JOB-ENGINEERED DIFFERENCES IN EVERY CLASS OF

ESSEX

FILM COATED

magnet wire

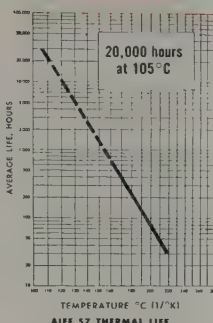
There's a "right-wire" for you in this full Essex line. Each one has job engineered differences specifically developed for your applications. Selecting the proper Essex magnet wire, will assure you of greater efficiency... with minimum trouble and down time. Some of the differences and applications are typified in the examples given below.

Enamel	Formvar	Acrylic	Modified Formvar	Self-Bonding Formvar	Nylon	Formvar-Nylon Comb.	Urethane	Non Stripping Urethane	Urethane-Nylon Comb.	Self-Bonding Urethane	Epoxy	Mod. Polyester	Silicone	ML*
Class 105C	Class 105C	Class 105C	Class 105C	Class 105C	Class 105C	Class 105C	Class 105C	Class 105C	Class 130C	Class 105C	Class 130C	Class 155C	Class 180C	Class 220C
Plain or Black Enamel	Formvar	Acrylex	Formetex	Bondex	Nylon	Nylorm	Soderex	Gripex	Soderon	Soderbond Soderbond N	Epoxy	Poly-Thermalex Nylorm Thermalex F	Silicone	Allex

FORMVAR

Service record unequalled in wire industry assures years of trouble free service. Size range—round wire 4 through 52 single, heavy, triple, quadruple. Squares and rectangles up to 100,000 square mils.

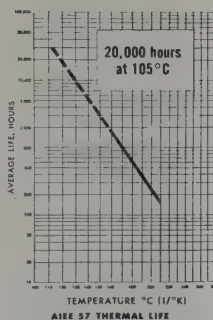
Applications: Class A motor windings, round wire coils of all types, hermetic applications when hermetic grade specified, shaped wire coils, oil filled transformers.



NYFORM

The complete dependability of Formvar with a plus factor in windability. Size range—round 4 through 44 single, heavy, triple, quadruple.

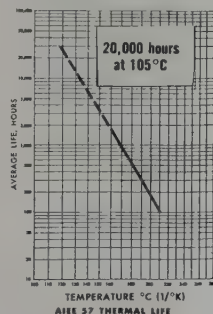
Applications: High speed motor windings, hand tool motor armatures, Class A coils and transformers of all types. Particular adaptability where overload resistance is required.



SODEREX®

Solderable without film removal. Size range—10 through 52 single, heavy, triple, quadruple.

Applications: Electronic coils, light duty motor and armature windings, transformer coils, relays. The correct choice for a product requiring solderability without stripping in the finer wire sizes. Particularly recommended for solderable insulation on sizes 28 and finer.

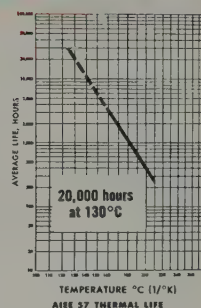


*E. I. duPont De Nemours & Co.—Type ML Resin.

SODERON®

Combines the features of Soderex with exceptional windability. Size range—4 through 44 single, heavy, triple, quadruple.

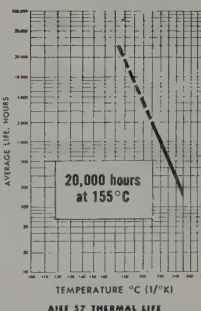
Applications: Light duty stator and armature windings, transformers, relays, coils. Particularly recommended for 27 and heavier wire where solderability is a requirement.



POLY-THERMALEX/PTX

A Class F magnet wire at Class A prices offering machine windability. Size range—4 through 40 single, heavy, triple, quadruple. Squares and rectangles up to 100,000 square mils.

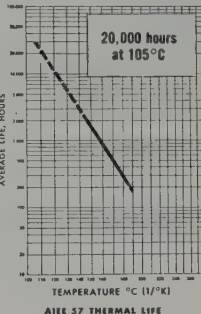
Applications: General purposes—motors Class A through F, dry type transformers, relay coils. An excellent replacement for glass fabric wire.



PLAIN ENAMEL

Premium wire at a reduced cost for coil work. Size range—10 through 52 single and heavy.

Applications: Relays, paper section coils, power transformers, low voltage automotive coils. Will not exhibit resistance to physical abuse associated with synthetic films.



For your magnet wire planning contact Essex for instant assistance



**MAGNET WIRE
DIVISION**

ESSEX WIRE CORPORATION
Fort Wayne, Indiana
National Network of Warehouses and Sales Offices

Print Ins. 36 on Reader Service Card

in the electrical and other industries. The Polymer Corp., 2120 Fairmont Ave., Reading, Pa.

Print No. Ins. 105 on Reader Service Card

Four Curing Agents Give Broad Range to Epoxy Paste Adhesive

"Epon" adhesive 901, a solvent-free epoxy paste, can be cured with four versatile liquid curing agents for a wide range of industrial bonding applications. The epoxy resin is a grey paste. When it is mixed with any of the four curing agents, the resultant adhesives are thixotropic even during cure at high temperatures. The cured adhesives supply tensile strengths up

to 3800 psi. They are said to be resistant to salt spray, water, and most organic liquids, and to bond metals, rubber, reinforced plastics, glass, ceramics and bondable nylon and "Teflon"—to each other or in almost any combination of materials. The four curing agents offer cure conditions from room temperature to 300°F and will meet most bonding requirements. Curing agents A, B-1, and B-2 are color-indicating. They change the adhesive color from grey to red when paste and liquid have been mixed thoroughly. Shell Chemical Co., Adhesives Dept., Pittsburg, Calif.

Print No. Ins. 106 on Reader Service Card



Hess Goldsmith Fiberglass Tapes serve your most precise requirements. Over 150 varieties, in widths of $\frac{1}{4}$ " to 2", in thicknesses from .003" to .025". All meet highest quality standards. All are in stock at 15 distribution centers located in major cities from coast to coast. 

Horace Linton Division, Hess, Goldsmith & Co., Inc.
Makers of Quality Fiberglass Tapes...including Hesgon
1400 Broadway, New York 18—A division of Burlington Industries

Print Ins. 37 on Reader Service Card

Pressure Sensitive Vinyl Tape For 105°C Operation

The first pressure-sensitive vinyl plastic tape reported to be designed for continuous operation at class A (105°C) operation, called "Scotch" brand electrical tape No. 66, is a black, polyvinyl chloride film coated on one side with a newly developed



acrylic polymer pressure-sensitive adhesive. The new adhesive is said to combine heat, oil, and solvent resistance with resistance to plasticizers, making it suitable for applications where plasticizer migration from low temperature wire insulation has limited the use of tape. The tape is said to be conformable for tight application to irregular surfaces and contours, has sufficient strength for machine wrapping operations, and provides maximum electrical protection with minimum build-up. The vinyl backing is resistant to sunlight, rain, snow, salt water, and alkalis, and is self-extinguishing. Typical applications include the replacement of riveted or cemented fiber insulation in switchboards; insulation of bus bars, TV high voltage cages or similar components, coil covers, and capacitors; insulation and protection of electrical wiring in appliances and industrial equipment; harnessing, cabling, or strap insulation; or wherever a non-corrosive dielectric barrier is required. A tensile strength of 35 lb/in width, electric strength of 11,000 v, insulation resistance of 1×10^6 megohms, and electrolytic corrosion factor ratio of 1.0 are claimed for 11 mil thick tape. Dept. W1-47, Minnesota Mining and Manufacturing Co., 900 Bush Ave., St. Paul 6, Minn.

Print No. Ins. 107 on Reader Service Card

Electrical Grade Nylon in Slab Form

New line of "Zytel" 31 (electrical grade) nylon slab is available in sizes 12" x 12" in thicknesses from $1/16$ " to 1", and 12" x 36" in thicknesses

how TEAMWORK PIONEERED the use of COLOR in PLASTIC JACKET CABLES

Lenz Electric Manufacturing Co. fill the need in the electronics industry for color in plastic jacketed cables. In pioneering the development and use, Lenz Engineers called upon the Blane Corporation for a vinyl insulating material to various extent that would offer clarity, clarity and permanent identification of cables before, during, and after installation.

Lenz specified that the material must facilitate connections between electronic units, make cable-to-cable bonds and improve each cable jacket cable to the flow dull and monotonous shades.

The result is Blane's color vinyl jacketing compounds.

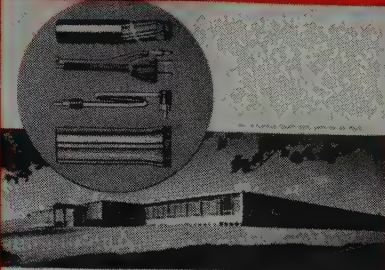
We quote Lenz for its initiative in this important program of raising the industry's standards by producing quality, profitable and economical color plastic jacketed cable.

Blane is proud of the part it has played in helping to introduce color for plastic cable applications.

THE BLANE CORPORATION
CANTON, MASSACHUSETTS




HOW TEAMWORK PRODUCES QUALITY PRODUCTS FOR WIRE & CABLE USERS



Philo Plastic Corp., Shrewsbury, Mass. is a leading wire and cable manufacturer. They used The Blane Corporation's insulating materials, have teamed together to solve industry needs.

For example, in 1958 the industry required a 1/2" Compound Jacket with good high heat temperature properties. To meet this need Philo developed #3143 and Philo covered the use in 51, 105°C applications as well as for CSA requirements.

In 1960, Blane's research and development staff worked with Philo's engineering staff to make available to the industry a vinyl solution material meeting the desired 115°C operating limit in 1/2" and 1/4" wall thicknesses with a good margin of safety.

The result is Blane's #3143 compound. We quote Philo Plastic Corp. for their high engineering requirements which ensure the industry that only top performing materials will be used in their products.

Blane is proud to be one of the suppliers of this important company serving the wire, cable, and electronic industries.

THE BLANE CORPORATION
CANTON, MASSACHUSETTS



HOW TEAMWORK RESULTED IN 5 BIG BENEFITS FOR WIRE AND CABLE USERS

- Lower Working
- Consistency of Product Orders
- Fewer Delivery Calls
- Speed of Development
- Elimination of Time Wastes

Yard Cable Co., Portland, P. I., had big wire and cable requirements. They wanted The Blane Corporation #3143 in a shorter working time cycle resulting in the use of Blane's #3143.

Card reported that the cable which could be electrically connected directly to the fiber that the need a reduced and the short delivery time was a major assurance that the working time cycle would be maintained in an important order.

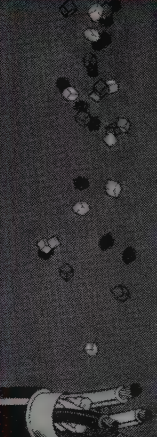
With its in cooperation with Card Engineering, Yard reported that the #3143 compound is a good cable jacketing material. It is a good cable jacketing material. It is a good cable jacketing material. It is a good cable jacketing material.

Blane is proud to be one of the suppliers of this important company serving the wire, cable, and electronic industries.

THE BLANE CORPORATION
CANTON, MASSACHUSETTS



HOW TEAMWORK INTRODUCED A NEW SHAPE IN VINYL COLOR CONCENTRATES



Jefferson Wire and Cable Corp., New York, N. Y., is a leading wire and cable manufacturer. They used The Blane Corporation's insulating materials, have teamed together to solve industry needs.

For example, in 1958 the industry required a 1/2" Compound Jacket with good high heat temperature properties. To meet this need Philo developed #3143 and Philo covered the use in 51, 105°C applications as well as for CSA requirements.

In 1960, Blane's research and development staff worked with Philo's engineering staff to make available to the industry a vinyl solution material meeting the desired 115°C operating limit in 1/2" and 1/4" wall thicknesses with a good margin of safety.

The result is Blane's #3143 compound. We quote Philo Plastic Corp. for their high engineering requirements which ensure the industry that only top performing materials will be used in their products.

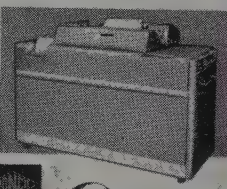
Blane is proud to be one of the suppliers of this important company serving the wire, cable, and electronic industries.

THE BLANE CORPORATION
CANTON, MASSACHUSETTS



**THIS IS
INDUSTRY
TEAMWORK
IN ACTION!**

PRECISION BUSINESS MACHINE



Blane Corporation's precision business machine is a leading wire and cable manufacturer. They used The Blane Corporation's insulating materials, have teamed together to solve industry needs.

For example, in 1958 the industry required a 1/2" Compound Jacket with good high heat temperature properties. To meet this need Philo developed #3143 and Philo covered the use in 51, 105°C applications as well as for CSA requirements.

In 1960, Blane's research and development staff worked with Philo's engineering staff to make available to the industry a vinyl solution material meeting the desired 115°C operating limit in 1/2" and 1/4" wall thicknesses with a good margin of safety.

The result is Blane's #3143 compound. We quote Philo Plastic Corp. for their high engineering requirements which ensure the industry that only top performing materials will be used in their products.

Blane is proud to be one of the suppliers of this important company serving the wire, cable, and electronic industries.

THE BLANE CORPORATION
CANTON, MASSACHUSETTS



These are some of the companies that have teamed with BLANE in its research and development program.

This is teamwork that has proven to be progressive, practical, and profitable to all.

In 1961 our Research and Development staff is working on many important insulation projects. In conjunction with this expanding program, we are offering our services and facilities to all wire and cable manufacturers in a combined effort to solve current and long term insulation problems.

Teaming up with BLANE can be profitable for you, too. We extend an invitation to contact The Blane Man. He will be pleased to be of service.

THE BLANE CORPORATION
CANTON, MASSACHUSETTS



from 1/16" to 1/2". Low moisture absorption, improved dimensional stability, easy machinability, and good electrical properties reportedly make the new slab especially attractive for mass-produced electro-mechanical parts. A. L. Hyde Co., Grenloch, N.J.

Print No. Ins. 108 on Reader Service Card

'Teflon' Lined Rubber Cable Tubing

The outstanding physical and chemical properties and advantages of Teflon tubing and the thermal protection, scuff, weather and oil resistance of neoprene are combined in Teflon lined rubber tubing for use in a wide variety of applications where protection to the Teflon is required to pre-



vent kinking or collapsing in service. The neoprene covering is said to withstand a continuous service temperature of 200°F (93°C) for several months without cracking. Applications include electrical and electronic cabling. The Teflon tubing reportedly is unaffected by any commercial chemical, has the widest service temperature range of any plastic, and has good dielectric strength (500 to 2000 vpm). Pennsylvania Fluorocarbon Co. Inc., 1115 N. 38th St., Philadelphia 4, Pa.

Print No. Ins. 109 on Reader Service Card

Epoxy Resin Curing Agents

New epoxy resin curing agents in liquid form reportedly give amine-type cures yet have low toxicity, are easy to handle, and have long pot life (several weeks to several months). Resins cured with the agents are said to have excellent electrical properties, heat distortion temperatures up to 130°C, and resistance to water and aqueous acid and alkalies. It is also stated that class B resins can be formed for laminating. U. S. Borax Research Corp., subsidiary of United

States Borax & Chemical Corp., 412 Crescent Way, Anaheim, Calif.

Print No. Ins. 110 on Reader Service Card

Transparent Vinyl Sleeve Resists Heat, Fungus, Oil, and Acid Attack

New transparent vinyl insulation sleeving reportedly combines outstanding resistance to heat, fungus, and oil attack. Called "Resinite" Hi-Heat 105C, it is designed for electric motor insulation and over transformer leads and other applications in both ground-employed and airborne electronic assemblies. The insulation sleeving has approval from Underwriters Laboratories, and surpasses all specification requirements for MIL-I-631C Type F, Form U, Grade C, Classes I and II, Cat. 1. Its dielectric strength is rated at 1000 vpm average. Working temperature is from 221°F to -10°F (105°C to -23.3°C), with continuous operations at 105°C. The material is said to be self-extinguishing in 5 secs, completely fungus resistant, and impervious to oil and acid attack. Technical data and samples available. Dept. H, Resinite Dept., The Borden Chemical Co., One Clark

need better PUNCHINGS?

West Virginia produces two high-quality pressboards especially suited for punchings:

ELECTRITE: A hard board for all kinds of punchings; punches clean and smooth. Electrite is natural rosin sized to resist moisture, with high tensile strength.

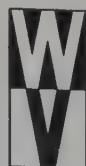
DENSITE: An extremely hard board, sized for moisture resistance or unsized for applications in oil.

Electrite and Densite are superior because they are made from 100% virgin kraft pulp from our own mill. Complete product control from forest to you assures

consistent uniformity and absolute purity, with no metallic particles.

See How Our Pressboard Can Help You:

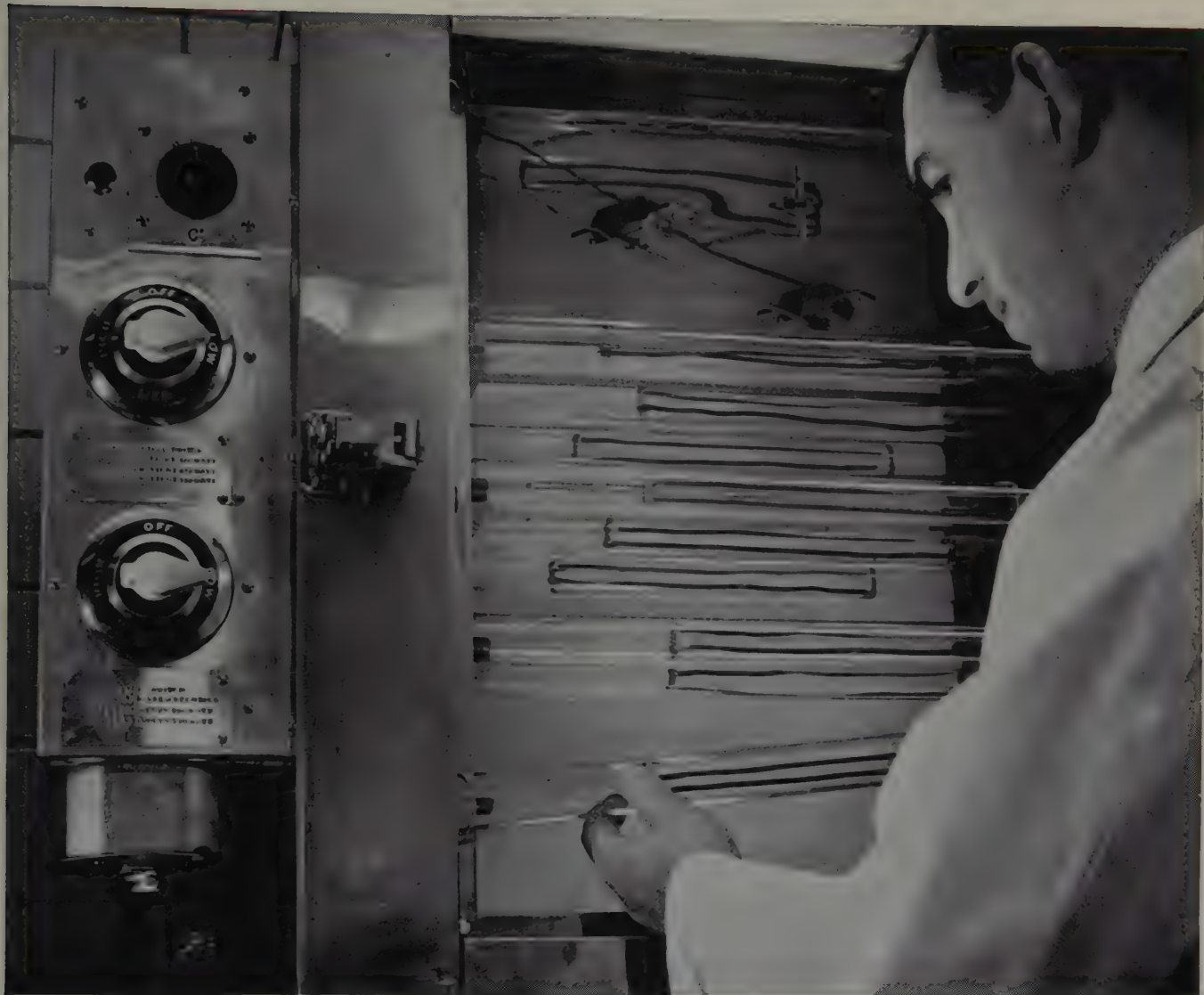
Write for complete technical data, and Underwriters' Laboratories Report #E3987. Board Products Sales, West Virginia Pulp and Paper Co., Covington, Virginia.



**West Virginia
Pulp and Paper**

Print Ins. 39 on Reader Service Card

WHAT'S NEWS IN ENJAY TECHNICAL SERVICE



Enjay helps reduce cost of 90°C vinyl wire insulation...

An important part of Enjay Technical Service is developing useful new products that reduce costs, yet maintain performance. Ditridecyl phthalate for use in plasticizing vinyl wire insulation is a good example of this research activity. By tests, such as the oven aging shown above, Enjay was able to prove that DTDP, made from Enjay tridecyl alcohol, performs as an efficient, non-volatile plasticizer for 90°C wire — yet reduces plasticizer cost.

Test results, at right, show that the insulation exceeds the U.L. Specifications.

Enjay research facilities and technical skills are available to customers in the vinyl wire, film and sheeting industries.

If you would like to receive a free copy of our new Technical Bulletin No. 20 on Enjay oxo alcohol for plasticizers, write to 15 West 51st Street, New York 19, N. Y.

TEST RESULTS: 7 DAYS @ 121°C

	U. L. Specification Minimum	OTDP Plasticizer
Elongation	65% retention	100% retention
Tensile Strength	65% retention	101% retention
Dielectric Strength	50% retention	127% retention
Insulation Resistance*	.01 megohm based on 1000 ft.	0.36 megohm based on 1000 ft.

* 1 day and 7 days @ 113°C.

EXCITING NEW PRODUCTS THROUGH PETRO-CHEMISTRY

ENJAY CHEMICAL COMPANY

A DIVISION OF HUMBLE OIL & REFINING COMPANY

Print Ins. 40 on Reader Service Card



5 Ways Better...

Varglas SILICONE RUBBER Tubing and Sleeving

1. WON'T CRACK, PEEL OR CRAZE
2. GREATER FLEXIBILITY
3. HIGH DIELECTRIC RETENTION
4. LONG LIFE CUTS REPLACEMENT COSTS
5. VIVID COLORS FOR READY IDENTIFICATION

THERMAL PROPERTIES:

Heat aging: 1000 hrs. at 250° C without appreciable change in physical or dielectric properties.

FLAMMABILITY:

Self-extinguishing, when tested in accordance with ASTM and NEMA procedures. (NEMA Acceptance Test).

ABRASION RESISTANCE:

Durable and extra tough. Withstands unusual rough handling at all times.

Twist, bend, wrap or knot it and this tubing remains pliable and efficient, even under the most severe operating conditions. Send for free samples today.

CHEMICAL INERTNESS:

Has good resistance to all oils, alcohols, dilute acids and alkalis. Fine water resistant qualities.

FLEXIBILITY:

Unaffected throughout life of Tubing. Stays flexible from minus 90° F. to plus 600° F.

FUNGUS RESISTANCE:

Inert. No fungus growth was visible at 40 x magnification after 28 days incubation under "ideal" surroundings.

GREATLY ENLARGED

end of Varglas Silicone Rubber Tubing shows design that permits knotting, bending and twisting to meet extremes of temperature while retaining its dielectric strength.



VARFLEX SALES CO., INC.
320 N. Jay St., Rome, N.Y.

Please send me sample with Bulletin and Prices.

Name _____
Title _____
Company _____

Print Ins. 41 on Reader Service Card

St., North Andover, Mass.
Print No. Ins. 111 on Reader Service Card

Cellulose-Reinforced Phenolic Molding Compound

Excellent preforming and molding characteristics are featured in a new medium-impact phenolic. Designated RX 522, it is a two-step, cellulose-reinforced compound which can be compression, transfer, or plunger molded. Recommended for use in all types of automatic molding equipment, the material molds to a lustrous, black finish. Among properties reported are a bulk factor of 2.8 to 1, impact strength of 0.4 (min) ft lbs/in of notch, flexural strength of 11,000 (min) psi, tensile strength of 8,000 (min) psi, water absorption rate of .5%, and a short time dielectric strength of 300 (min) vpm. Rogers Corp., Rogers, Conn.

Print No. Ins. 112 on Reader Service Card

Thixotropic Epoxy Resin

"Polycast" No. 1204 is a new semi-rigid epoxy resin system that has thixotropic properties. It can be used to coat transformers or other electrical components with a single dip, and reportedly has no run-off while curing. The resin is said to resist thermal shocks between -65°C to +150°C and to have excellent electrical properties before and after humidity cycling. Transformers coated with Polycast No. 1204 and impregnated with Polycast No. 1202 pass the requirements of MIL T 27A, Class "S". Wright Plastics Inc., 114-13 Atlantic Ave., Richmond Hill, N.Y.

Print No. Ins. 113 on Reader Service Card

Diallyl Phthalate Prototype Stock

Parts and configurations molded of "Diall" (diallyl phthalate resin-based) compounds are said to permit prospective customers to machine and test prototypes of plastics parts without incurring the expense of building special dies to mold them. The configurations include panels, slugs, rods, bars, discs, and cylinders in various dimensions. Custom parts made from specially-built dies are supplied at slightly higher prices. Stock to be machined by users is X-ray inspected. Unusual insulating, electrical, and dimensional stability properties re-

portedly are maintained in extremely adverse environments. Mesa Plastics Co., 12270 Nebraska Ave., Los Angeles 22, Calif.

Print No. Ins. 114 on Reader Service Card

Latex Compositions for Films, Coatings, and Impregnations

A new variety of "Viton" latex compositions are known as "Peltex." All types and varieties of applications are said to be possible with these latices using standard techniques normally required in the use of other rubber types of latex. The high temperature and oil resistance normally obtained with compounded Viton reportedly permit thin films, coatings, impregnations, and linings as well as other end use possibilities. Peltex is non-flammable. Available in natural as well as a variety of colors. Pelmor Laboratories Inc., 401 Lafayette St., Newtown, Bucks Co., Pa.

Print No. Ins. 115 on Reader Service Card

Solution Increases Resistance of Paper to Water and Weathering

A new air-drying solvent solution is said to substantially increase the resistance of paper and paperboard products to water and weathering. Designated "Impregnole" 367, the material is a mixture of silicone polymers and other film-forming ingredients. It is designed to be used diluted in solvent to approximately 5 to 10% solids and may be applied by spraying or swabbing, followed by air drying. Properties reported include flash point of more than 80°F, 50% solids, and non-corroding. Paper Chemicals Dept., Warwick Chemical Div., Sun Chemical Corp., Wood River Junction, R.I.

Print No. Ins. 116 on Reader Service Card

Vinyl Resins

Two new vinyl copolymers, "Trulon" 750 and 760 are composed of vinyl chloride and vinyl acetate. The white resins flow freely when dry and have a bulk density of 28 (± 2) lbs/cu ft. Both have a specific gravity of 1.36, a volatile content of 2.0% max, and a vinyl acetate content of 13 to 15%. Specific viscosity, 0.4% in nitrobenzene @ -25°C, is 0.17 (± 0.02) for 760 and 0.21 (± 0.02) for 750. Thompson Chemical Co.,

NOW... Commercially Available!

NEW MILAM FLAKE GLASS *Composites*

4 year development and production program — in cooperation with Owens-Corning Fiberglas Corporation — produced this remarkable new flexible insulation with important economic advantages.

Milam's new Flake Glass Composites are combinations of flexible flake glass paper and mechanical carriers, offering substantial savings in high temperature applications. Virtually unlimited electrical and mechanical characteristics can be produced.

Economically, these composites compare favorably with other inorganic papers. For example, these are about one-third the cost of mica paper or mica splittings.

Three Milam Flake Glass Composites are currently being manufactured in production quantities. These consist of flake glass paper laminated to Mylar* film and/or woven glass cloth. Other composites using mechanical carriers such as electrical grade papers, varnished glass cloth, non-woven synthetic fiber mats, etc., can also be made.

Milam's experience and know-how gained through 4 years of developing and producing flake glass composites are now available to assist industry members in specific applications.

Write for complete information and technical brochure.

*Mylar — DuPont's trademark for its polyester film.

MILAM

MILAM ELECTRIC MFG. CO.

A subsidiary of Thompson Ramo Wooldridge Inc.

1100 ELMWOOD AVE. • PROVIDENCE 7, R.I.

Stuart 1-2284

Representatives in Principal U. S. Cities and Foreign Countries

261-37

Print Ins. 42 on Reader Service Card

TEFLON*

HEADQUARTERS U.S.A.



SHEETS • RODS • TUBES • TAPES • HOSE

BONDABLE TEFLON • MACHINED PARTS • SPECIALTIES

One call does it all. Ask the man from R/M for *anything* you need in "Teflon"—standard shapes to finished parts. He can satisfy your requirements fast and efficiently.

By any measurement—research, complete line, experience, technical data, capacity, quality control, delivery and reputation—R/M should be your *first source* for "Teflon" products.

R/M "Teflon" Headquarters has grown to its present stature through outstanding dependability in its *own* production and delivery and in the performance of finished products.

Contact your nearest R/M district office listed below... or write for a copy of the latest catalog featuring R/M "Teflon" products.

*Registered TM for Du Pont fluorocarbon resins



PLASTIC PRODUCTS DIVISION

RAYBESTOS-MANHATTAN, INC.

Manheim, Pa.

BIRMINGHAM 1 • CHICAGO 31 • CLEVELAND 16 • DALLAS 26 • DENVER 16 • DETROIT 2
HOUSTON 1 • LOS ANGELES 58 • MINNEAPOLIS 16 • NEW ORLEANS 17 • PASSAIC • PHILADELPHIA 3
PITTSBURGH 22 • SOUTH SAN FRANCISCO 5 • SEATTLE 4 • PETERBOROUGH, ONTARIO, CANADA

SPECIALISTS IN ASBESTOS, RUBBER, ENGINEERED PLASTICS, SINTERED METAL
Print Ins. 43 on Reader Service Card

Pawtucket, R.I.

Print No. Ins. 117 on Reader Service Card

New Process Metalizes 'Teflon,' Other Plastics and Rubber

Teflon, other high temperature plastics, and rubber can be metalized by a new process in which copper or nickel is deposited over the entire surface or selected areas. The extremely thin, (millionth of an inch) metal film is electrically conductive, and can be built up to any desirable thickness by conventional electroplating methods. The new process reportedly gives an extremely tenacious bond between the metal coating and substrate—substantially stronger than that produced by current adhesive laminating techniques. Sheet materials and sophisticated molded components are under development for prototype applications in the electronic, missile, and aircraft industries. Joclin Manufacturing Co., Lufbery Ave., Wallingford, Conn.

Print No. Ins. 118 on Reader Service Card

Fast Bonding, Two-Part Epoxy Adhesive

New rapid bonding liquid epoxy adhesive is suitable for use at room temperature. Setting in 45 secs, X-305 is said to immediately provide tensile shear strengths in excess of 2000 psi. Outstanding features reported are non-flammability, low exotherm (250°F max), lack of fuming on setting, and easy to use non-critical mixing ratio (by either weight or volume). The 2 to 1 mixing ratio lends itself to hand cementing techniques and also the use of dual spray gun or mixing/metering equipment. Adhesive is recommended in applications requiring quick setting adhesives such as repairs to printed circuits, fastening and sealing of electronic components and other devices, laminating, etc. Mereco Products Div., Metachem Resins Corp., 530 Wellington Ave., Cranston, R.I.

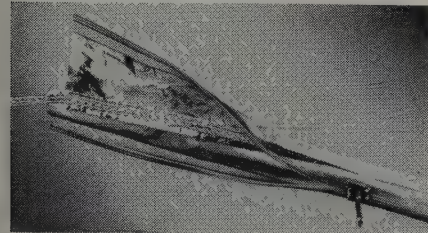
Print No. Ins. 119 on Reader Service Card

Glass Metallized for Soldering

Glass with surface metallized for soldering may be used in fabricating hermetically sealed assemblies for aircraft and missile equipment. The glass shapes are produced in a wide range of sizes and shapes. Electro-Seal Corp.,

**Shielded Zippertubing Prevents
Transient RF Interference**

New type SH shielded zippertubing with 1 mil aluminum foil laminated to vinyl impregnated glass cloth has been developed to solve transient RF interference problems. Edge of the aluminum shielding has aluminum braid which facilitates grounding and assures contact and coverage of the entire circumference. The tubing is a pliable conduit that is shipped in flat form. A plastic zipper simplifies cable jacket application—tubing is simply placed around the wires and zipped close. Repair and maintenance of cables are also simplified, as the cable is easily zipped open for inspection. If desired, the cable jacket zipper may

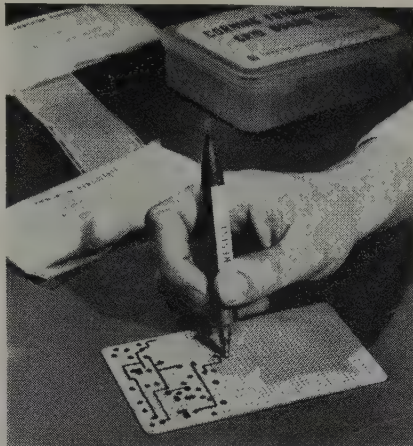


be permanently sealed. The Zipper-tubing Co., 13000 S. Broadway, Los Angeles 61, Calif.

Print No. Ins. 121 on Reader Service Card

'Fotoceram' Printed Circuit Kits

Fotoceram grid boards have been put into kits that provide a designer with all materials needed to make prototype printed circuitry in 15 minutes, without leaving his desk. The



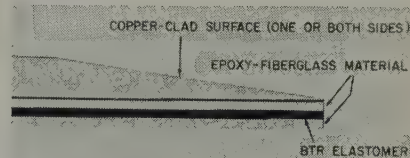
kits contain the etching resists and etching materials that work best with the copper-clad Fotoceram glass-ceramic. Prices are \$8.95 for kits con-

taining two boards and \$1.95 for kits without boards. Corning Electronic Components, Bradford, Pa.

Print No. Ins. 122 on Reader Service Card

Integrally Damped Circuit Boards

New, highly damped material for printed circuit boards aids designers to raise reliability levels of high-density electronic packages for aerospace applications. It converts vibratory energy into shear strains which are dissipated in an elastomeric layer



bonded between elements of epoxy fiber glass laminate. The elastomer reportedly exhibits unchanging characteristics under all environmental conditions. The damping layer is a special form of a "BTR" (Broad Temperature Range) elastomer, a highly damped material which is said to operate over the -65°F to $+250^{\circ}\text{F}$ (-53.9°C to $+121^{\circ}\text{C}$) temperature range, resist environmental ex-

Which Wire Construction is Best ...

Hudson makes all three in bare and plated constructions. Each is best suited for particular applications and insulating materials. For many years, the industry "standards" were bunch and concentric strandings. But with Hudson's marketing of unilay, there has been a strong swing to this versatile construction.

... for your Application

BUNCH constructions are generally used for flexible cords and fixture wires complying with UL standards, ASTM, and all military specs where permitted.

UNILAY constructions should be utilized where concentricity is a major requirement, or for economic reasons to get more for your insulating dollar. Since unilay constructions are preformed and twisted in the same direction, they are uniform and smaller in O.D. than bunched or concentric constructions. Unilay constructions are suited for all bunched applications, and are being substituted for concentrics in many applications with comparable performance at considerably lower conductor cost.

CONCENTRIC Where concentric strand conductors are required by customer or military spec, Hudson's concentric wires will meet the most exacting requirements.

For additional information on stranded and single-end conductors — bare and plated — write to:

HUDSON WIRE COMPANY
OSSINING DIVISION, OSSINING, NEW YORK TELEPHONE: WILSON 1-8500

trems, and to adapt to normal processing methods. It is anticipated that these properties of the new material will greatly extend design freedom and aid miniaturization in high-density electronic packaging. In the printed circuit board application, Dyna-damp is stated to have successfully resisted the processing materials and temperatures used in preparing, etching, and soldering. Lord Mfg. Co., Erie, Pa.

Print No. Ins. 123 on Reader Service Card

Polycarbonate Rod and Slab

Rods and slabs of "Lexan" polycarbonate thermoplastic are available in rod diameters from $\frac{1}{4}$ " to 4", and slab thicknesses from $\frac{1}{8}$ " to 1". Exceptionally high impact strength, dimensional stability, and heat-resistance, plus good electrical properties are claimed. A. L. Hyde Co., Grenloch, N.J.

Print No. Ins. 124 on Reader Service Card

Low Cost Epoxy Casting Resin for Embedding Coils and Transformers

"Stycast" 3180M epoxy casting resin with a mixing ratio of 1:1, by



either weight or volume, is adaptable to either production dispensing equipment or to manual mixing for smaller batches. Compatible with electrical components and circuits, embedment of coils and transformers is a particularly attractive application. It is stated to bond extremely well to most materials. Excellent machinability, high insulating qualities, moisture resistance, and thermal stability are claimed. Cost runs from 55 to 66 cents/lb. Cure at room temperature in a few hours or in a few minutes at moderate temperatures is reported. Technical bulletin No. 7-2-24 avail-

able. Emerson & Cumming Inc., Canton, Mass.

Print No. Ins. 125 on Reader Service Card

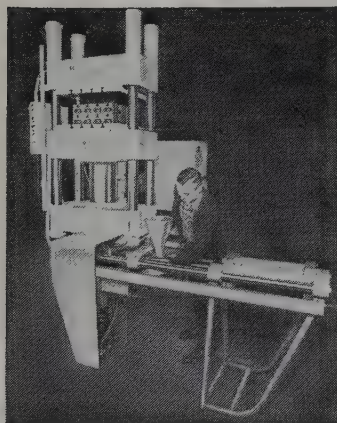
Alumina Feed-Throughs For Hermetic Seals

New series of hermetic feed-through seals for electronic components operating in high altitude military aircraft equipment are complex alumina bushings composed of a threaded ceramic, a flange, and solid feed through. Two types have been produced: $\frac{1}{2}$ " in diameter and 1" long, and $\frac{3}{4}$ " in diameter and $19/16$ " in length. Stated to be capable of operating up to 900°C, they are designed to leak no more than 1 cu cm in 30 yrs of operation. All parts are mass spectrometer tested. Parts are claimed to withstand shock up to 10,000 G's. Cost is less than \$2 in lots of 2,000 or more. Ceramics International Corp., 39 Sid-ing Place, Mahwah, N.J.

Print No. Ins. 126 on Reader Service Card

Heavy Duty Terminals Cut Vibration Breakage

A new line of heavy duty solderless electrical terminals is designed to resist heavy vibration that fractures standard terminals. Formed from heavier stock (.50"), line is supplied



GET THE HULL STORY

FOR YOUR LABORATORY OR PRODUCTION EQUIPMENT NEEDS, AND FOR APPLICATION ENGINEERING ASSISTANCE IN THE FOLLOWING BROAD AREAS:

- Compression and Transfer Molding
- Vacuum Impregnation and Potting
- Encapsulation
- Vacuum Metallizing
- Relay Drying and Filling
- Liquid Resin Metering, Mixing, Dispensing
- Vacuum Casting
- Vacuum Heat Treating
- Freeze Drying

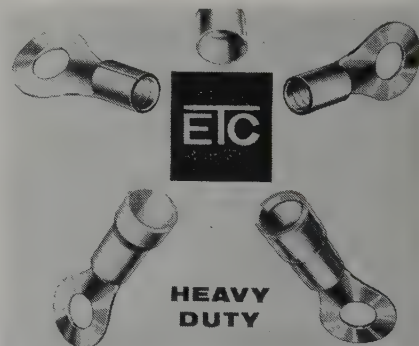
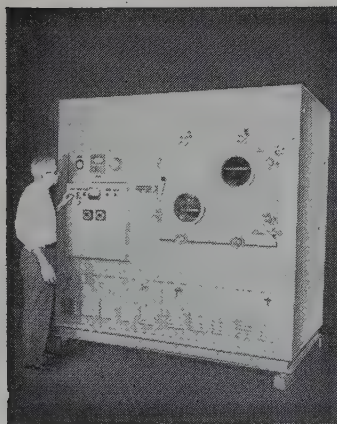
UP-TO-DATE SYSTEMS — BOTH STANDARD & CUSTOM

HULL CORPORATION

Hatboro, Pennsylvania

Export Division: 1505 Race St., Philadelphia 2, Penna.

Print Ins. 45 on Reader Service Card



in over 200 styles, types, and sizes—rings, spades, etc., insulated and non-insulated. All regular ETC barrel styles are available. Samples, prices, and literature are available. ETC Inc., 990 East 67th St., Cleveland 3, Ohio.

Print No. Ins. 127 on Reader Service Card

"And remember, my friends," the lecturer told his audience, "There will be no buying and selling in Heaven . . ."

"That," mumbled a businessman at a back table, "is not where business has gone." "By Gum" Reichhold Chemicals, Inc.

Practical approach to compactness

is demonstrated by this flame retardant, interphase insulating barrier for magnetic air circuit breakers.

When the equipment was designed, CDF utilized its extensive knowledge of adhesives and post-forming to provide the barriers from a flame retardant, paper base phenolic laminate.

Result: two pieces bonded together to provide three channels in one unit, reducing size and cost, yet maintaining effective electrical insulating properties.

A few facts on the laminate:

Flame resistance: ASTM D-635

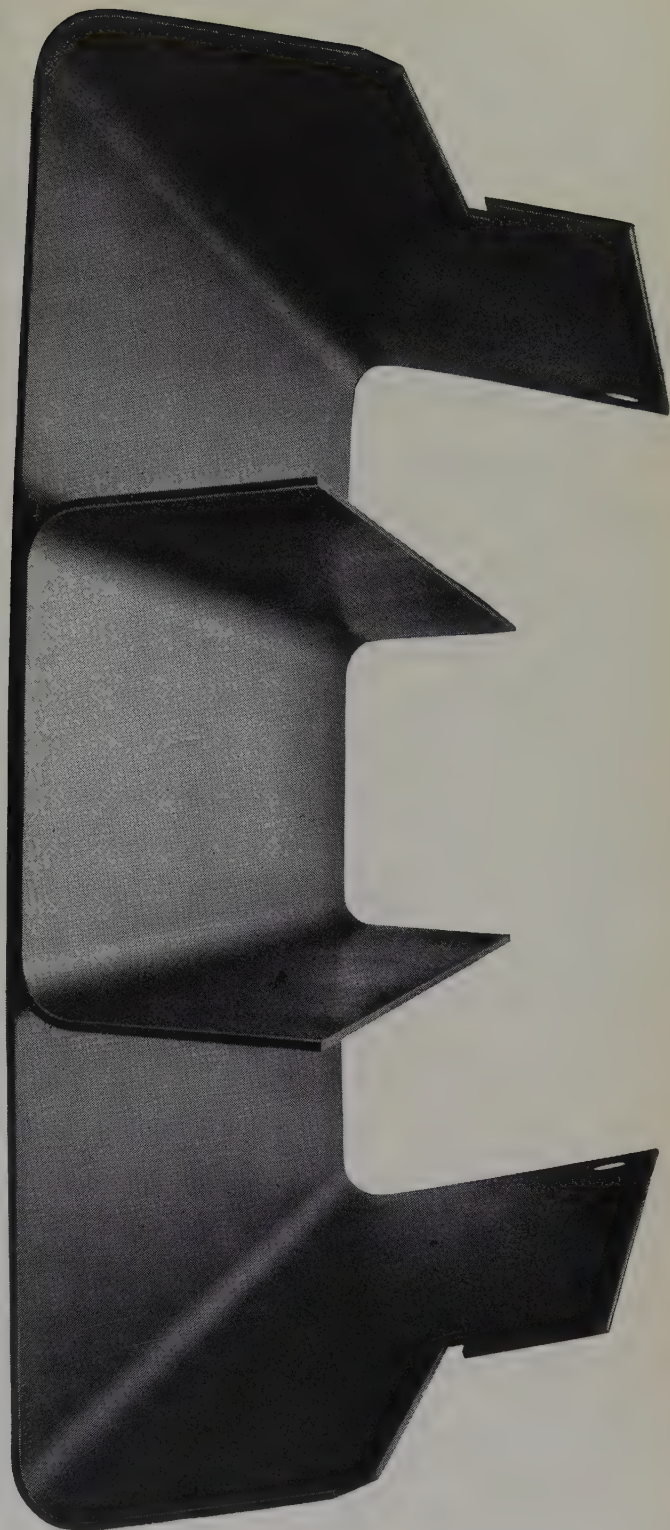
... self extinguishing

Water absorption, % 1.8

Flexural strength, psi 12,000

Specific gravity 1.38

Dielectric strength, parallel, kv . . . 40



CONTINENTAL-DIAMOND FIBRE

RIEDEL ELECTRONIC BOARD

**For standard
or modified
systems**



Riegel Electronic Board is used with confidence everywhere . . . for transformers, rotating machinery, cylinders, bushings and coil forms. Whether your manufacturing requires standard or modified electronic board, you can get it from Riegel. Riegel Electronic Board is cylinder kraft made with optimum balance of electrical, mechanical and chemical properties. It is free from lumps, grit and metal impurities and can be tested 100% for conducting paths.

Riegel Electronic Board can be supplied plain and coated with shellac, wax or special resins to your specific requirements . . . in sheets or rolls . . . thicknesses from 0.003 to 0.031". Write for electrical data folder: Riegel Paper Corporation, Box 250, New York 16.

Riegel

**SPECIALIST IN
ELECTRICAL PAPERS**

Coated Electronic Board	Electronic Board
Waxed Electronic Board	Cable Insulating
Dacron Paper	Conductive Paper
Resin Impregnated Paper	
... and many others	

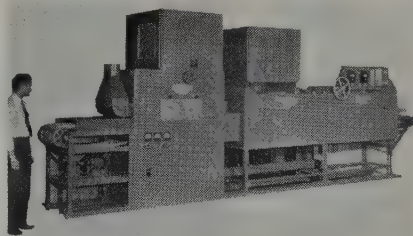
Print Ins. 47 on Reader Service Card

New Instruments and Equipment

For further information on these products print the item number on the Reader Service Inquiry Card on the back cover. Fill out and mail the card —no postage is required. Insulation will immediately forward your inquiry to the manufacturers concerned so that they can send you more information promptly.

Induction Heating Unit for Curing Impregnated Papers

New heating equipment reportedly cures impregnated papers of all kinds. It handles double rows of paper up to 6" wide each, feeding two production lines at a time when desired, or any single width up to 12". The equipment consists of a 7½ kw dielec-

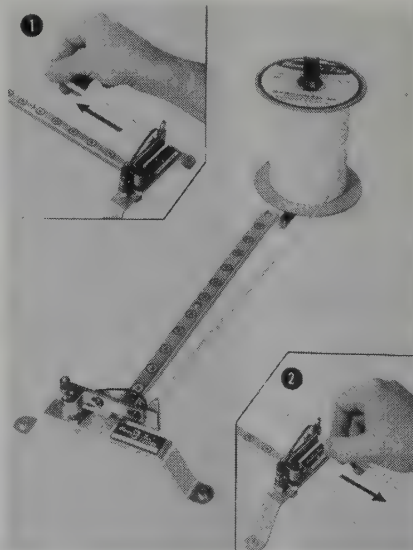


tric generator with an oven-like insulated cabinet through which the paper is conveyed. Radiant heaters equalize surface heating. Induction Heating Corp., 181 Wythe Ave., Brooklyn, N.Y.

Print No. Ins. 201 on Reader Service Card

Faster Tying with New Cutter

A new inexpensive measuring cutter that speeds up tying and bundling

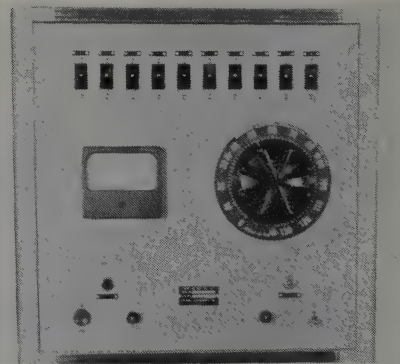


operations is designed primarily for use with wire-reinforced paper or plastic ties. It measures and cuts any bundling materials, such as ribbon, reinforced tape, wire, cord, etc. The user grasps the stock at any desired length, and in a single movement inserts and cuts off neatly in a unique swinging cutting arm. The Hanscom cutter is lightweight, mounts on bench or wall, and costs \$7.95. H. F. Hanscom & Co. Inc., Dept. NR, 1 Virginia Ave., Providence 5, R.I.

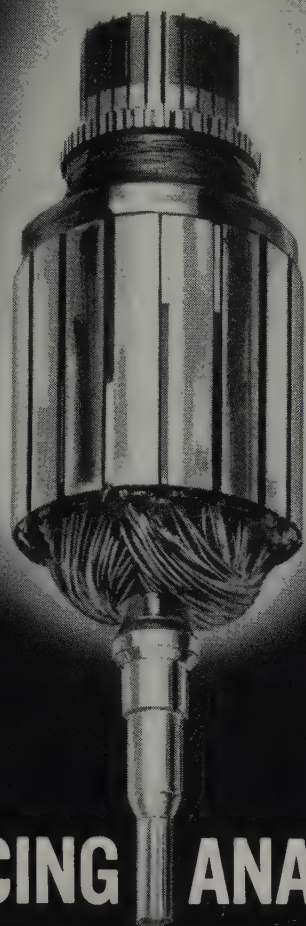
Print No. Ins. 202 on Reader Service Card

Multiple Output Dielectric Test Set

Designed to simultaneously test 10 reels of wire or cable in production plants, the new model K3-4Y automatically disconnects faulty specimens and permits others to remain on test. It features an independent fault indicator for each channel, optional timer for timed tests, zero start high voltage on hold push button, safety door interlock and external interlock, plus other usual convenience and safety features. Rated at 0 to 3 kv



rms and 4 kva capacity, the test set has a continuously adjustable output voltage, a linear scale kilovoltmeter with field recalibration facility, and 10 separate output terminals behind an interlocked door. All 10 outputs need not be energized if not required. Other applications include the dielectric testing of multi-conductor cable, life tests on a group of components or specimens of insulating material, and where the ratio of testing time to loading time is favorable. Input is 115 v, 60 cps, and 35 amps at full load. Size is 22" x 15" x 21" high,



ANNOUNCING ANACONDA ML

FILM-COATED MAGNET WIRE FOR 220 C

Affords continuous high-temperature operation up to 250 C—resists heat shock up to 425 C

The exceptional heat stability of Anaconda ML Magnet Wire makes it ideal for electrical equipment operating at continuous high temperatures up to 250 C—such as high-temperature motors, relays and dry-type transformers. This same heat-resistant characteristic also makes ML Magnet Wire a valuable tool in miniaturization and in reducing the size of larger equipment.

Tremendous overload resistance (as demonstrated by thermo-plastic flow above 500 C and heat shock resistance over 400 C) makes ML Magnet Wire particularly suitable for portable tool armatures and other applications where "stall" conditions or unusual overloads may be experienced.

Essentially zero weight loss to 200 C makes it possible to use ML Magnet Wire for relays that will operate at temperatures up to 250 C with low space factor and comparatively low cost. Using ML Magnet Wire in sealed relays practically eliminates contact contamination due to "outgassing" of wire insulation.

Other ML Magnet Wire advantages: high burn-out resistance and cut-through level; dry dielectric strength over 3,000 V/Mil; excellent flexibility; good windability and scrape resistance.

ML Magnet Wire is coated with a solution of ML Polymer, a new chemical development by duPont that represents a

tremendous improvement in heat resistance over organic coatings. ML Magnet Wire can be used as a replacement for most film-coated magnet wires, except solderable types, and many glass and glass Dacron wires. Where the positive inorganic spacing of glass is required, the combination of ML film and glass serving offers outstanding properties. ML Magnet Wire's combination of high temperature rating, excellent winding characteristics and space factor permits its use in many applications which formerly required the use of much more expensive combinations of ceramics and fluorocarbons.

ML Magnet Wire is available in all sizes of round, square and rectangular. Film additions are single, heavy, triple or quadruple thicknesses, all conforming with NEMA specifications. ML also meets all requirements of Spec. MIL-W-583B for Class 180 Types H, H2, H3, and H4, and Class 200 Types K, K2, K3, and K4. For prices, technical data and applications engineering information, contact Department EFL-1-I, Anaconda Wire and Cable Company, 25 Broadway, New York 4, New York.

ASK THE MAN FROM
ANACONDA[®]
 FOR ML MAGNET WIRE

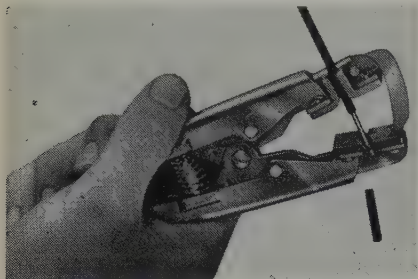
Print Ins. 48 on Reader Service Card

and weight is 220 lbs. Price is \$1500. Peschel Electronics Inc., Towners, Patterson, N.Y.

Print No. Ins. 203 on Reader Service Card

Wire Stripper

A new tool that works like a pair of pliers strips insulation from both stranded and solid wire. A single squeeze on the handles reportedly strips wire clean, without nicking. An arm automatically drops down to hold

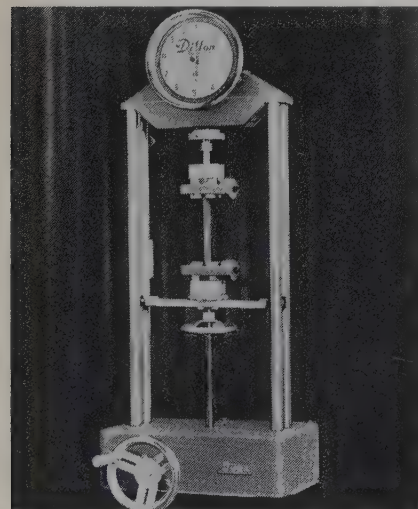


jaws open and prevent crushing of stranded wire. After wire is removed, a second squeeze releases arm and stripper is ready for the next wire. Price is \$5.65. Holub Industries Inc., Sycamore, Ill.

Print No. Ins. 204 on Reader Service Card

Strength Tester with Extra Wide Work Area

Extra large sections of materials can be positioned and tested in new model LW extra wide tester. Standard width between the uprights has been increased approximately from 8¾" to 14½". Four daylight openings are available (12", 20", 30", 40") to permit fixture travel in excess of the greatest anticipated elongation. The instruments are made in seven capacities: 0-250 lb, 0-500 lb, 0-1000 lb, 0-2500 lb, 0-5000 lb, 0-7500 lb, and 0-10000 lb. Tests of tensile, trans-

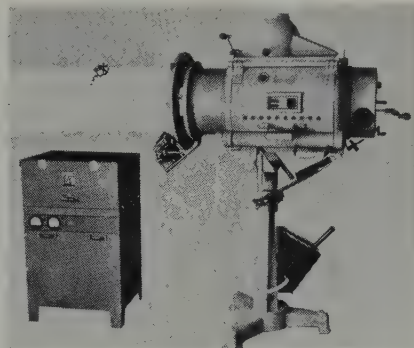


verse, compression, and shear can be made on materials with tensile strength varying from only a few pounds to as high as 400,000 psi. W. C. Dillon & Co. Inc., 14620 Keswick St., Van Nuys, Calif.

Print No. Ins. 205 on Reader Service Card

Solar Radiation Simulator

Model ME4 solar radiation simulator, designed for testing space vehicles and other components in a beam of collimated radiation which has the same spectrum, intensity, and divergence as the sun in outer atmosphere,



produces a beam of radiation 12" in diameter. It is supplied with a rectifier and operates from 3 phase, 220 v a-c. Genarco Inc., 97-04 Sutphin Blvd., Jamaica, N.Y.

Print No. Ins. 206 on Reader Service Card

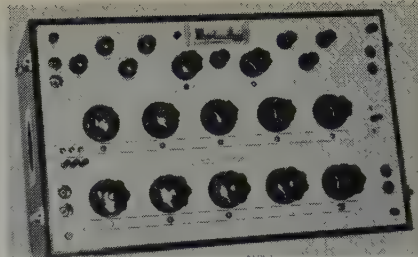
Ultrasonic Drill Machines Glass, Ceramics, Etc.

A new "Glennite" ultrasonic drill, model D-101A, is said to be almost twice as efficient in multiple machining, slicing, cutting, and etching operations as the older model D-100A. The new drill will handle tool sizes up to ¾" on a diagonal. Sample per-minute-rates using this size tool include glass at .200" and ceramic at .060". Successful impact grindings have been made with the new drill to produce delicate engravings in glass and accurate dicing of semiconductor materials. It drills holes as small as .002" diameter, and can be used to drill holes in glass or ceramic insulators for electronic tubes and in fiber glass reinforced epoxy resin. Price is \$1,875, including the generator. Vibro-Ceramics Div., Gulton Industries Inc., 212 Durham Ave., Metuchen, N.J.

Print No. Ins. 207 on Reader Service Card

High Voltage Capacitance Bridge

Designed for studies of dielectric

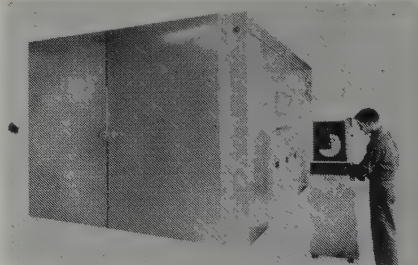


losses as a function of test voltage as well as capacitance measurements from 1 pf to 100 µf, new high voltage capacitance bridge features an accuracy of 0.1% (±1) pf and a maximum test voltage of 1,000 v a-c. Frequency range of the bridge is 50 cps to 10 kc. Other features reported include elimination of errors due to stray capacitances and adequate protection for the bridge. Rohde & Schwarz Sales Co. (USA), Inc., 111 Lexington Ave., Passaic, N.J.

Print No. Ins. 208 on Reader Service Card

Walk-in Environmental Chamber

A new walk-in style environmental chamber has a capacity of 2,100 cu ft for electronic and other applications. Model WF-2100-125+300H provides a temperature range of from +300°F to -125°F (+149°C to -87.2°C), and a relative humidity range of from 20 to 95%. Inside unobstructed usable space is 15' left to right x 20' front to back x 7' high. The chamber fea-



tures a patented cascade arrangement and automatic defrost, and has a thermal capacity of 56,000 Btu's. There is said to be less than one degree air stratification within the interior. Special frost-free viewing windows and portholes are provided. Exterior dimensions are 16'4" x 22'2" x 8'4". Webber Manufacturing Co. Inc., P. O. Box 217, Indianapolis 6, Ind.

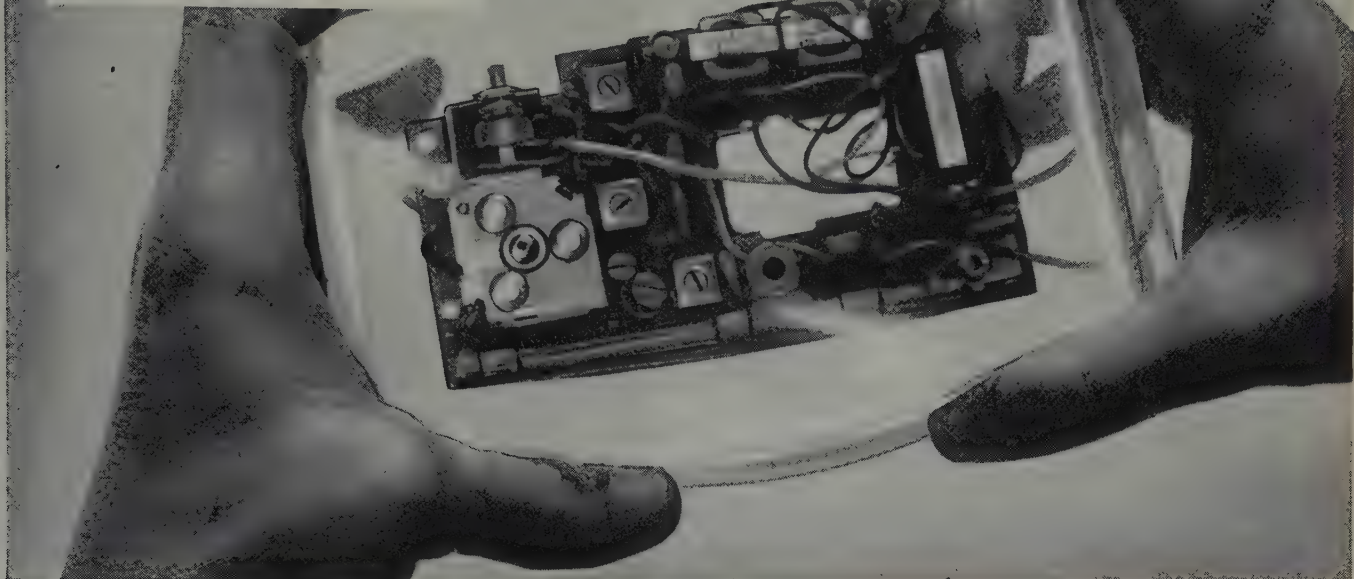
Print No. Ins. 209 on Reader Service Card

High Voltage Test Sets

A new expanded line of compact high voltage test sets consists of an increased number of ratings in a-c sets and a standard line of d-c sets. They conform to ASTM specification

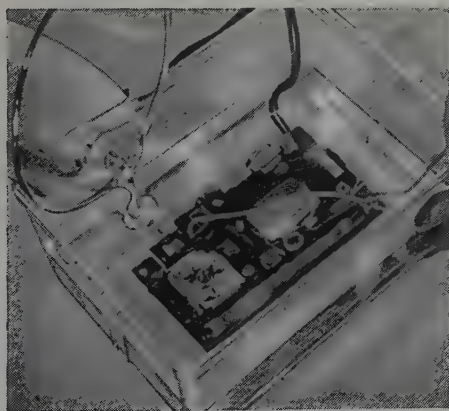
A clear, solventless liquid, General Electric clear LTV-602* cures at 75-80°C to form a resilient compound with excellent electrical properties. Even thick sections are perfectly transparent. Useful from -65 to 175°C, this self-supporting material provides protection against thermal shock, vibration, moisture, ozone, dust and other hazards.

*Low Temperature Vulcanizing

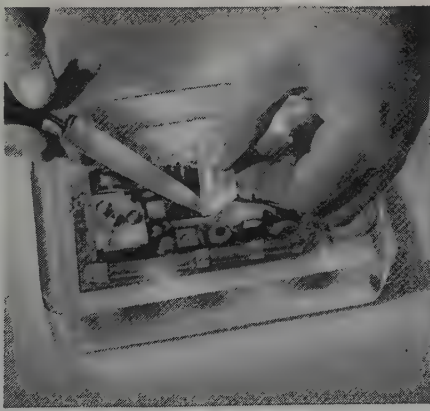


General Electric clear LTV silicone compound for potting and embedding

Transparent, resilient, self-supporting and easy to repair



LTV-602 is easily applied, flows freely in-and-around complicated parts. Having a low viscosity in the uncured state, 800-1500 centipoise, LTV is ideal for potting and embedding of electronic assemblies. Unlike "gel-like" potting materials, LTV-602 cures to a flexible solid. Oven cure is overnight, or from 6 to 8 hours at 75 to 80°C.



LTV-602 is easy to work with and easy to repair. To repair parts embedded in LTV, merely cut out and remove section of material, repair or replace defective part, pour fresh LTV into opening and cure. Pot life, with catalyst added, is approximately 8 hours and may be extended with refrigeration. When desirable, LTV may also be cured at room temperature.



Resiliency offers excellent shock resistance. LTV-602 easily meets thermal shock tests described in MIL-STD-202A test condition B which specifies five temperature cycles from -65 to 125°C. Tests indicate that LTV retains protective properties even after 1800 hours aging at 175°C. Other tests confirm LTV's resistance to moisture and water immersion.

LTV-602 is the newest addition to the broad line of G-E silicone potting and encapsulating materials which also include the RTV silicone rubbers. For more information, write to General Electric Company, Silicone Products Department, Section M540, Waterford, New York.

GENERAL  ELECTRIC

Print Ins. 49 on Reader Service Card

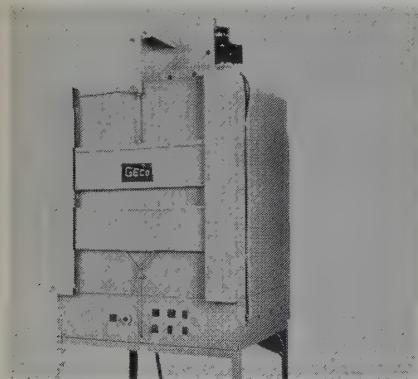


D-149-59, and can be used to test dielectric materials and all kinds of insulated electrical apparatus such as motors, generators, transformers, wires, and cables. Sphere gaps, for voltage measurement, and equipment for testing dielectric strength of insulating liquids are also available for use in conjunction with the sets. The a-c line consists of 15 ratings in two classifications: 2 kva at voltage ratings of 20, 35, and 50 kv, and 5, 10, and 25 kva at voltage ratings of 50, 75, 100, and 150 kv. D-C sets are available at 5 and 10 ma at ratings ranging from 30 to 150 kv. New safety features and many optional features are available. General Electric Co., High Voltage Specialty Transformer Section, Holyoke, Mass.

Print No. Ins. 210 on Reader Service Card

Plastic Sheet Preheating Oven

Plastic sheet preheating ovens are equipped with air operated doors, leaving the operator's hands free for faster cycles. Ovens are forced convection types with automatic thermo-

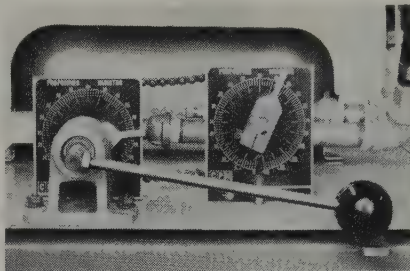


static control. High air flow reportedly insures even temperatures with no danger of overheating. The model HSP ovens are available to handle 18" x 18", 24" x 24", and 36" x 36" sheets. Gruenberg Electric Co. Inc., 9 Commercial Ave., Garden City, N.Y.

Print No. Ins. 211 on Reader Service Card

Unit Proportions, Mixes, and Dispenses Multi-Component Resins

The Multi-Rez-Processor for proportioning, dispensing, and mixing multi-component reactive resins such as epoxies and polyurethanes maintains proportional accuracy of the two component media dispensed through mechanical linkage operating positive displacement pumps. The proportioning linkage of the unit has been completely redesigned, allowing for simplified changes of ratio without substitution of sprockets or gears.

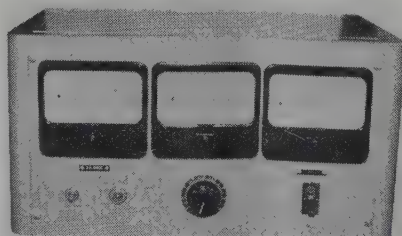


Redesign, called the Proportion-Variator, permits changes in ratio settings with a simple adjustment of an arm around a calibrated dial. The new feature broadens the ratio range, allowing settings of 1:1 and 100:1. In addition, the equipment will dispense an adjustable predetermined volume of the two components in proportion. CPM Special Machinery Corp., 324 Butler St., Brooklyn 17, N.Y.

Print No. Ins. 212 on Reader Service Card

A-C/D-C Test Set for Use Up to 1000 Volts

For voltages up to 1000 v, high-capacity a-c/d-c test set model KS1-50 features both a-c and d-c output channels with separate 4" voltmeters for a-c rms and d-c, plus a common a-c/d-c current meter. Additional features include continuously adjustable output, simplified control circuitry with main switch, pilot lamp, high-speed circuit breaker selected for full capacity of test set, voltmeters directly across high voltage output for maxi-

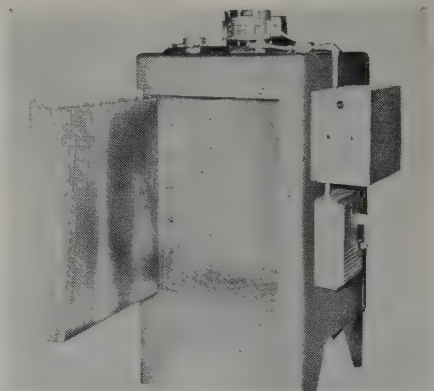


mum accuracy, current meter in ground lead, all meters and controls at ground potential, and a self-contained metal cabinet measuring 17" x 9" x 11" and weighing 30 lbs. Current capacity is 50 ma on a-c and 25 ma on d-c. It is designed for lab or production dielectric testing in accordance with ASTM standards, or as a general purpose power supply. Price is \$395. Peschel Electronics Inc., Towners, Patterson, N.Y.

Print No. Ins. 213 on Reader Service Card

Ovens for Use to 650°F and to 1200°F

Two improved model lines in a forced convection series of ovens provide closely controlled heat for processes with operating ranges to 1200°F. WOF oven line ranges from 6 to 45 kw. from 24" x 36" x 18" to 60" x 72" x 60" inside, and operates on 240/480 v, except in the smallest ovens which are 240 v only. Temperature range is 650°F (short runs to 750°F), suitable for such uses as epoxy resin encapsulation and motor

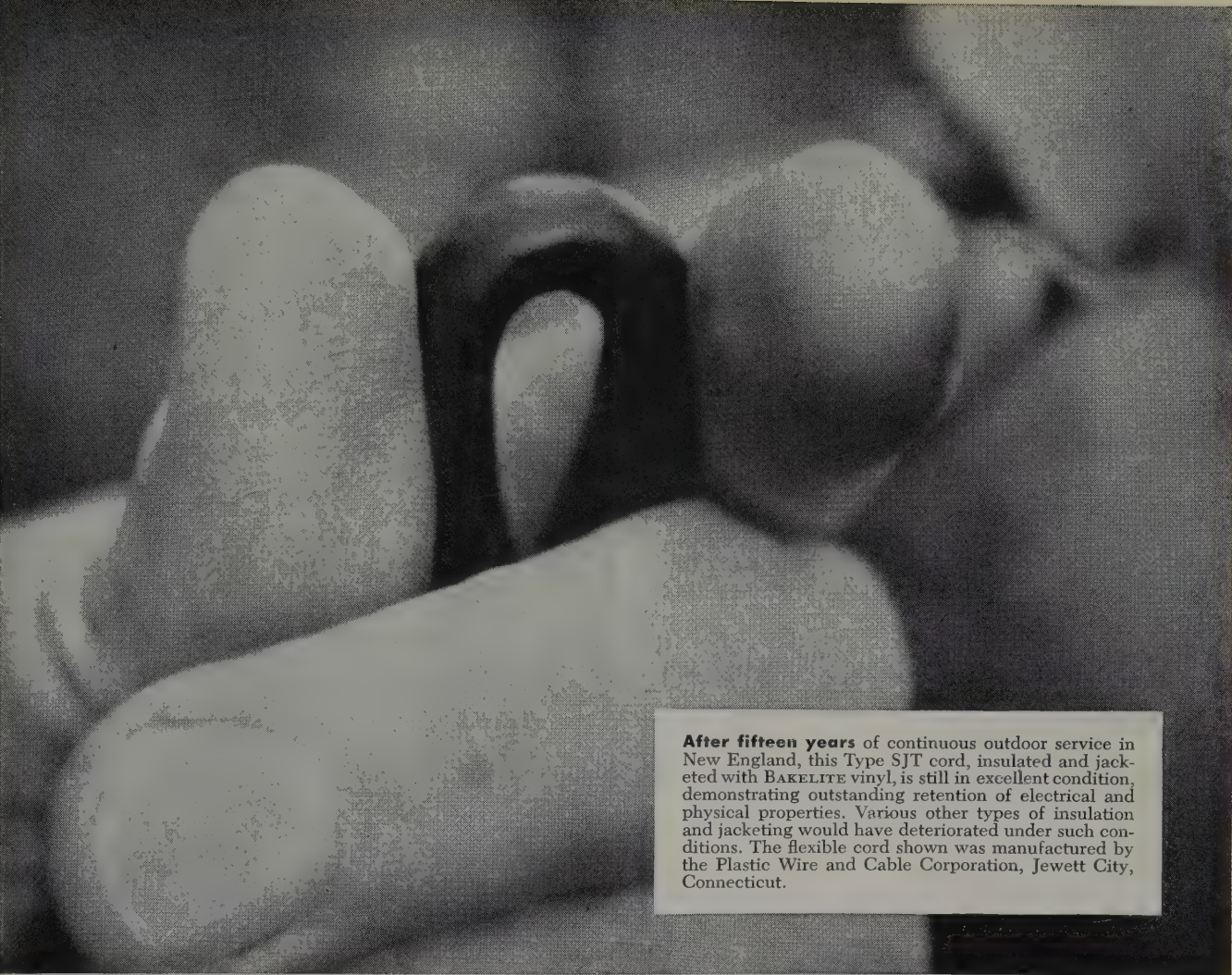


bake-out. HTOF ovens, for operating ranges to 1200°F, are available in models from 9 to 60 kw, 240/480 v, and in the same range of inside dimensions as the WOF line. Both ovens are furnished as packaged units. Trent Inc., 211 Leverington Ave., Philadelphia 27, Pa.

Print No. Ins. 214 on Reader Service Card

The Russian and the American space ships landed on the moon at the same time. The hatches slowly opened and the first humans to step on the surface of the moon slowly approached each other. Soon they came face to face. "Hans!" cried one.

"Otto!" exclaimed the other. "Now we can speak German again."—*The Kablegram*.



After fifteen years of continuous outdoor service in New England, this Type SJT cord, insulated and jacketed with BAKELITE vinyl, is still in excellent condition, demonstrating outstanding retention of electrical and physical properties. Various other types of insulation and jacketing would have deteriorated under such conditions. The flexible cord shown was manufactured by the Plastic Wire and Cable Corporation, Jewett City, Connecticut.

With BAKELITE® Vinyl Insulation and Jacketing... you get this kind of reliability even after 15 years

This simple bend test can be an unusually severe one . . . especially for covered wire that has been exposed to the weather for 15 years. Despite such exposure, the electrical cord easily passed this and other tests, illustrating the high degree of reliability and safety provided by insulation and jacketing of BAKELITE vinyl. The outstanding long-term performance of these materials is further verified by the comparison shown in the table.

That's why an increasing number of wire and cable manufacturers are using BAKELITE vinyl as insulation and jacketing for their products. Through experience, they have learned that for utmost serviceability, quality BAKELITE vinyl offers an impressive list of advantages including . . . outstanding resistance to aging, exceptional toughness, resistance to deformation, moisture and chemicals, flame resistance, and good electrical properties.

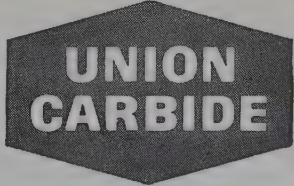
Demand the reliable performance that BAKELITE vinyl and polyethylene can provide your wire and cable products. For more information about BAKELITE Brand plastics, write Dept. JN-75E, Union Carbide Plastics Company, Division of Union Carbide Corporation, 270 Park Avenue, New York 17, N. Y. *In Canada:* Union Carbide Canada Limited, Toronto 12.

PHYSICAL PROPERTIES OF SJT CORD

Test Data shows excellent retention of properties even after 15 years operation.

	Underwriters' Laboratories' Minimum Requirements For Class II	Original	After 15 Years Service
Jacket			
Tensile Strength, psi	1600	1700	1510
Elongation, %	200	300	300
Primary Insulation			
Tensile Strength, psi	1600	3000	3500
Elongation, %	200	275	260

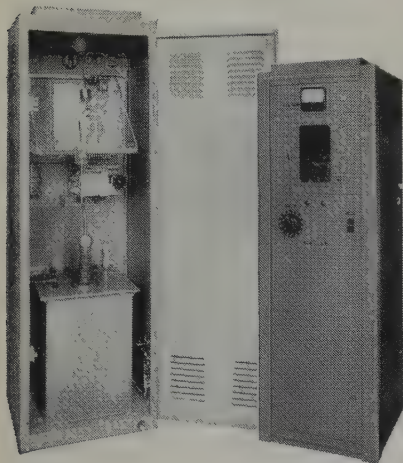
Electrical Safety Factor (after 15 years)—No breakdown with 50,000 volts applied between conductors. (This Type SJT cord is rated for only 300 volts.)



**UNION
CARBIDE**

BAKELITE and UNION CARBIDE are registered trade marks of Union Carbide Corporation.

SAFE! SIMPLE! ACCURATE!



AC BREAKDOWN TESTERS

Complete line of units designed for testing in accordance with ASTM D-149 and Federal Spec. LP-406, Method 4031, used for determination of dielectric strength and breakdown voltage safely, simply and accurately in the laboratory or on the production line.

FEATURES

- Completely self-contained
- Automatic rate of voltage rise
- Plug-in test electrodes
- Retention of voltmeter reading after breakdown
- Dual range units available for maximum versatility, up to six voltmeter ranges

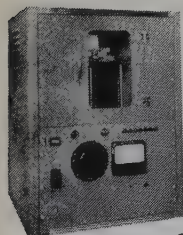
In addition to the standard models noted below, special models incorporating higher output ratings and a number of metering systems including primary metering, direct secondary metering, and digital output with recording can be provided.

Single Range	Dual Range Unit
15 KV, 2 KVA	50 KV, 2 KVA
15 KV, 5 KVA	and 10 KV, 2 KVA
25 KV, 2 KVA	25 KV, 2 KVA
25 KV, 5 KVA	and 5 KV, 2 KVA
50 KV, 2 KVA	
50 KV, 5 KVA	100 KV, 5 KVA
100 KV, 5 KVA	and 20 KV, 5 KVA

ARC RESISTANCE TESTER

Used for measuring the ability of insulating material to withstand high-voltage low-current arcs. Supplied in conformance with ASTM D-495 and Federal Spec. LP-406 Method 4011.2. Simplified operation includes automatic stepping and timing, and improved electrode holder. Operable by unskilled personnel.

Complete catalog of Electrical Test Equipment available on request.



**Industrial
Instruments Inc.**

89 Commerce Road, Cedar Grove, Essex County, N. J.

Print Ins. 51 on Reader Service Card

New Literature

All catalogs, bulletins, and other literature or sample cards described are available free of charge. To obtain your free copies, just print the item number on the Reader Service Card on the back cover. Fill out and mail the card—no postage is required. Insulation immediately forwards your requests to the companies concerned so that the literature can be sent to you promptly.

Bulletin of Plastics Processing Equipment

Bulletin E-1160 illustrates and describes modern production systems for impregnating, potting, encapsulating, plastics molding, relay drying and filling, urethane foaming, vacuum drying, upgrading of oils and waxes, vacuum melting, and heat treating. 8 pages. Hull Corp., Hatboro, Pa.

Print No. Ins. 300 on Reader Service Card

Reprint of Six Epoxy Articles

Reprint includes series of six articles on "New Developments in Epoxy Resins" which appeared in the Dec. 1960—May 1961 issues of *Insulation*. Subjects covered What Is an Epoxy Resin? . . . How Do You Specify One?, Curing Agents Available, Selecting an Epoxy Resin for Encapsulating Motors, Low-Cost Method for Encapsulating Motors, The Chemistry of Modern Magnet Wire Insulation, Handling and End-Use Properties. 40 pages. Union Carbide Plastics Co., Division of Union Carbide Corp., 270 Park Ave., New York 17, N.Y.

Print No. Ins. 301 on Reader Service Card

Booklet Describes Properties of New High Density Polyethylene

New Technical Bulletin No. 1 describes the properties and characteristics of "Ameripol" polyethylene—a new ethylene plastic polymer said to combine durability with processability. The illustrated booklet contains physical, chemical, and electrical property charts, as well as graphs comparing environmental stress cracking and environmental resistance of Ameripol to other high density materials. Also tabulated are figures to show thermal embrittlement resist-

ance and resistance to heat. Graphic illustrations of processability, a description of testing procedures, and recommended applications (such as wire and cable insulation) are covered. 12 pages. Goodrich-Gulf Chemicals Inc., 1717 East Ninth St., Cleveland 14, Ohio.

Print No. Ins. 302 on Reader Service Card

Catalog Gives Selection, Application Data for Laminated Plastics, Vulcanized Fibre

Basic application information and engineering data on laminated plastics and vulcanized fibre are given in a 1961 condensed catalog. Two pages describe laminated plastics and vulcanized fibre in general terms, telling how they are made and where they can be used. A two-page table lists general data and engineering data for 21 common grades of laminated plastics. The general data give suggested applications, corresponding NEMA grades, military specification, color, and forms and sizes in which furnished. The engineering data list typical physical, mechanical, and electrical properties. A second section gives substantially the same type of information for six grades of vulcanized fibre. Special grades are also described. 8 pages. Taylor Fibre Co., Norristown, Pa.

Print No. Ins. 303 on Reader Service Card

Bulletin Describes Clear Silicone Potting Compound

New illustrated bulletin (CDS-280) describes a recently developed clear silicone potting compound (LTV-602) designed to provide mechanical and dielectric protection for electronic components and assemblies. The bulletin lists complete properties of the compound and outlines a simple procedure for preparing it for use. 4 pages. General Electric Co., Silicone Products Dept., Waterford, N. Y.

Print No. Ins. 304 on Reader Service Card

Bulletins on Two Epoxy Powders For High Heat-Resistant Castings

Directions for high heat-resistant castings made in a few simple steps, and cured without catalysts, are con-

tained in new technical bulletins on two semiflexible, single-component epoxy casting powders. The bulletins describe unfilled powder #135E and filled powder #136E developed for encapsulating and impregnating transformers, coil windings, and other electrical and electronic components and equipment. Characteristics, distinctive properties, and easy-to-follow working instructions are given. 2 pages. Marblette Corp., 37-31 Thirtieth St., Long Island City 1, N. Y.

Print No. Ins. 305 on Reader Service Card

Industrial Ceramics Catalog

New catalog covers a complete line of industrial ceramics products. It includes photos, descriptive material, and sizes on beads, tubing and rods, swageable thermocouple tubing, end seals, castables, laboratory ceramics, and special shapes. Technical data on materials, electrical and mechanical properties, design recommendations, and a summary of facilities are also given. 20 pages. Saxonburg Ceramics Inc., Saxonburg, Pa.

Print No. Ins. 306 on Reader Service Card

Prepreg Booklet

The quality and processing advantages unique to prepregs or preimpregnated reinforced plastics and laminating materials, case studies on how and why more and more manufacturers are using prepregs, and tables on the resin-reinforcement combinations available, their characteristics and applications, are presented in the booklet, "Prepregs." 8 pages. Prepreg Div., The Society of the Plastics Industry, Inc. 250 Park Ave., New York 17.

Print No. Ins. 307 on Reader Service Card

Thermoplastics Comparison Chart

Thermoplastics comparison chart gives mechanical and electrical properties of "Lexan," "Delrin," "Zytel" 31 and 101, and "Implex" A, showing ASTM test method for each property. Chart is suitable for wall hanging. All materials listed are supplied in rod and slab forms. A. L. Hyde Co., Grenloch, N.J.

Print No. Ins. 308 on Reader Service Card

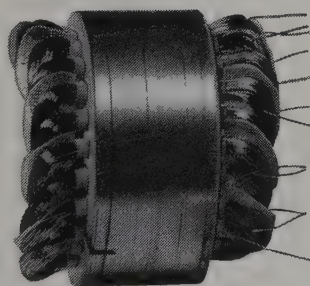
Brochure on Shapes and Parts Of "Rulon" and "Teflon"

New brochure #9572 compares the electrical, physical, mechanical, and

NOW FROM 3M RESEARCH



NEW COATED GLASS INSULATION SURVIVES CLASS F PUNISHMENT



Here's an exceptional insulation for motors, transformers, coils, and other electrical equipment that operates continuously at high temperatures. New "Irvington" Brand Epoxy Coated Glass No. 2525 retains its electric strength and flexibility even after sustained aging at rugged Class F temperatures. It is particularly suited for use in epoxy impregnated or cast units.

Extremely flexible and snug conforming, No. 2525 offers excellent compatibility with epoxy systems. It helps eliminate voids, hot spots, delaminations and moisture access points; will not contaminate or degrade transformer oils.

Use "Irvington" Epoxy Coated Glass No. 2525 for phase insulation, coil separator and interlayer insulation, or as an outer wrap on coils of all types. Available in tape, sheet or roll form in thicknesses of .003", .007" or .010". For further information write: 3M Company, 900 Bush Ave., St. Paul 6, Minnesota. Dept. ECA-51.

Irvington Division

MINNESOTA MINING AND MANUFACTURING COMPANY

... WHERE RESEARCH IS THE KEY TO TOMORROW

"IRVINGTON" IS A REGISTERED TRADEMARK OF 3M CO., ST. PAUL 6, MINN.



Print Ins. 52 on Reader Service Card

chemical properties of Rulon and Teflon. (Rulon is a reinforced TFE fluorocarbon resin said to offer all the advantages of Teflon—low friction, chemical inertness, zero moisture absorption, extreme temperature range—plus a considerable increase in both mechanical strength and wear resistance.) Numerous Rulon parts are illustrated. Also reviewed are engineering design services for developing special shapes and forms of Rulon and Teflon; prototype production facilities for custom molding and fabricating; and a laboratory for trial installation and performance testing of sample parts. 4 pages. Plastics Div., Dixon Corp., Bristol, R.I.

Print No. Ins. 309 on Reader Service Card

Bulletin on New Nylon Stock Shapes

New bulletin (No. MC-2) describes a new nylon formulation, MC Nylon. Physical and electrical property data and suggested applications are presented. Complete mill shape availabilities are listed, including large sizes of rod, tubular bar, and plate previously unavailable in other formulations. 4 pages. The Polymer Corp.,

Reading, Pa.

Print No. Ins. 310 on Reader Service Card

Brochure on Silicone Alloy Materials for Electronic Uses

A new brochure is devoted to silicone alloy materials for microwave and other electronics applications. Technical data on two types of "Isolantite" silicone alloys, including their physical as well as electrical properties, are contained in a full page, easy-to-read chart. These materials lend themselves for use in a wide variety of insulators. 4 pages. Isolantite Mfg. Corp., Warren Ave., Stirling, N.J.

Print No. Ins. 311 on Reader Service Card

Data Sheet on Flexible Epoxy Casting and Adhesive Resins

New technical data sheet on "Epoxy Casting and Adhesive Resins of Adjustable Flexibility" describes three basic hardeners which may be used and lists typical properties of cured flexible systems. Disintegrators for stripping cured epoxy, polyurethane, polyester, and similar compounds are also covered. Directions for use and prices are given. 2 pages. Isochem Resins Co., 221 Oak St., Providence

9, R.I.

Print No. Ins. 312 on Reader Service Card

Glass-Epoxy, Copper-Clad Laminate Is Described in New Bulletin

Grade GEC-500E copper-clad glass-epoxy laminated plastic, which features low moisture absorption with excellent chemical resistance and high mechanical strength, is described in Technical Data Bulletin 51.5.15. Other characteristics, thickness tolerances, applicable specifications, and properties of the composite sheets are given. 2 pages. Taylor Fibre Co., Norristown, Pa.

Print No. Ins. 313 on Reader Service Card

Magnet Wire Catalog

Catalog of film coated round copper magnet wires covers manufacturer's specifications (based on NEMA standards) and the machines used in specification tests, and gives technical data on single and heavy films of plain enamel, "Formvar," nylon, "Soderbrite," "Nyform," and "Isonel" coatings. A cross-reference chart of manufacturers' trade names, the thermal classification of insulation, and packaging, shipping, and ordering data are also given. 44 pages. Chicago Magnet Wire Corp., 345 N. Francisco Ave., Chicago 12.

Print No. Ins. 314 on Reader Service Card

RF Connector Catalog

New catalog contains illustrations and full technical data on all of the following series of RF connectors: BN, BNC, C, HN, LC-LT, LN, N, pulse, miniature and subminiature, twin connectors, UHF, miscellaneous connectors and adapters, adapters to rigid line, waveguide adapters, capacitated connectors, "Foamflex," "Spirafil," "Styroflex," power, TNC, K-Grip, polarized fuel gauge, coaxial cable termination, radiation resistant, 125 ohm high impedance, and hermaphrodite connectors. Also included are telephone jacks and plugs as well as connectors designed for specific applications. A 15-page cross-referencing index is also incorporated. 120 pages. Kings Electronics Co., Inc., 40 Marbledale Rd., Tuckahoe, N.Y.

Print No. Ins. 315 on Reader Service Card

Booklet on New Electronic Component Packaging and Interconnecting System

Booklet describes a new concept in



GUDELACE®...

the lacing tape with a NON-SKID tread

You can't see it, but it's there! Gudalace is built to grip—Gudebrod fills flat braided nylon with just the right amount of wax to produce a non-skid surface. Gudalace construction means no slips—so no tight pulls to cause strangulation and cold flow.

But Gudalace is soft and flat—stress is distributed evenly over the full width of the tape. No worry about cut thru or harshness to injure insulation . . . or fingers.

Specify Gudalace for *real* economy—faster lacing with fewer rejects.

Write for free Data Book.
It shows how Gudalace and other Gudebrod lacing materials fit your requirements.



GUDEBROD BROS. SILK CO., INC.

ELECTRONICS DIVISION
225 West 34th Street
New York 1, New York

EXECUTIVE OFFICES
12 South 12th Street
Philadelphia 7, Pa.

Print Ins. 53 on Reader Service Card

three-dimensional modular packaging and interconnecting of electronic components called AMP-MECA (Main-ainable Electronic Component Assemblies). The versatile characteristics and functions of the system, and the kinds of interconnections made possible because of AMP-MECA's modular-cell design, are discussed, with complementary illustrations. Included are illustrations of two AMP-MECA kits for prototype designing. 4 pages. AMP Inc., Harrisburg, Pa. **Print No. Ins. 316 on Reader Service Card**

Wire Engineering Data

New brochure (DM-6030) covers specification requirements and allowable current-carrying capacities of "Densheath" 900 industrial wire for general purpose power and lighting, high-temperature (90°C) applications, controls and switchboards, building, machine-tools, and appliances. Dept. EFL-P, Anaconda Wire and Cable Co., 25 Broadway, New York 4.

Print No. Ins. 317 on Reader Service Card

Bulletin on Threaded Inserts for Electrical Connections in Plastic

How a threaded "Clinch Insert" is used to form electrical connections, while providing permanent brass threads in plastics (after molding) and other soft parent materials, is described in new bulletin P-102. The bulletin explains how an electrical terminal can be attached securely to the insert by crimping the insert eyelet over the terminal. A table lists dimensions of each size and prices. Additional information covers hole size, simple tools for anchoring the insert, strength of assembly, and the availability of application assistance. 4 pages. Phelps Mfg. Div., Heli-Coil Corp., Danbury, Conn.

Print No. Ins. 318 on Reader Service Card

Catalog of Wire, Cable, Tubing, and Electronic Hardware

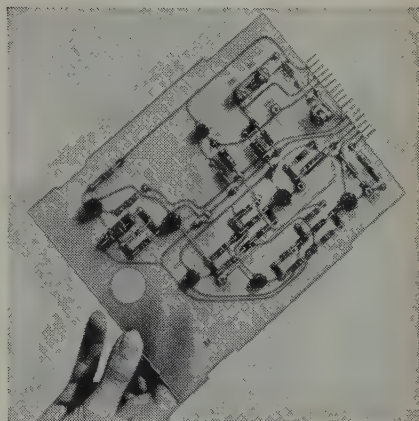
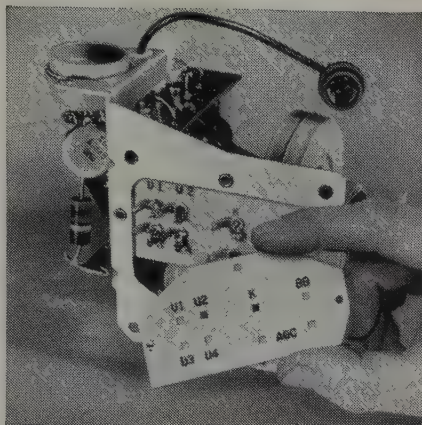
Revised catalog of wire, cable, tubing, and a variety of electronic hardware items lists properties, specifications, and other engineering data along with ordering information and prices. 44 pages. Birnbach Radio Co. Inc., 145 Hudson St., New York 13.

Print No. Ins. 319 on Reader Service Card

'Eeflon' Terminal Catalog

New catalog shows an entire line

Taylor glass-base laminates pop right out as design materials in many applications



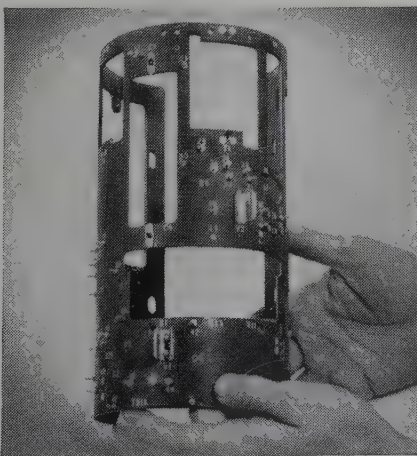
There are good reasons for investigating Taylor glass-base laminated plastics as high-strength-to-weight materials in your design. They offer light weight, corrosion resistance, electrical and thermal insulation, and ease of fabrication.

For example, glass-fabric-base laminates have the highest mechanical strength of all laminated plastic materials. They have been successfully used in the fabrication of critical parts, including aircraft parts and bases for printed circuits. They are most valuable where extremely low moisture absorption, increased heat resistance and superior electrical properties are required.

Taylor Fibre produces a number

of different glass-base grades in sheet, rod and tubular form, and copper-clad. Those with phenolic resin are recommended for mechanical and electrical applications requiring heat resistance. Those with melamine are characterized by their excellent resistance to arcing and tracking in electrical applications. They also have good resistance to flame, heat and moderate concentrations of alkalis and most solvents. Those with silicone exhibit very high heat resistance, combined with good mechanical and electrical properties. They also have highest arc resistance. Those with epoxy offer extremely high mechanical strength, excellent chemical resistance, low moisture absorption, and high strength retention at elevated temperatures.

Technical data about these and other Taylor laminated plastics are available. Ask for your copy of the Taylor Laminated Plastics Selection Guide. Taylor Fibre Co., Norristown 51, Pa.



Taylor
LAMINATED PLASTICS VULCANIZED FIBRE

Print Ins. 54 on Reader Service Card

of "Press-Fit" Teflon terminals available, including subminiature and miniature stand-offs, feed-throughs, probes and plugs, connectors, test jacks, and insertion tools. Technical and ordering data are listed. 4 pages. Sealelectro Corp., 610 Fayette Ave., Mamaroneck, N.Y.

Print No. Ins. 320 on Reader Service Card

Laboratory News Reports Latest Instrumentation Developments

Aminco Laboratory News, published quarterly, reports interesting electrical and other applications of Aminco instruments, new processes



and developments, and the latest scientific aids available. Aminco Laboratory News, American Instrument Co.

Inc., 8030 Georgia Ave., Silver Spring, Md.

Print No. Ins. 321 on Reader Service Card

Folder on Advantages and Equipment for Marking Wire

New folder on equipment for marking insulated wires and sleeving gives the technical advantages of letter-numeral marking for code identification of electrical wire harnesses and illustrates the latest Kingsley hand operated, motor driven, and air operated wire and tube marking machines. 4 pages. Kingsley Machine Co., 850 Cahuenga Blvd., Hollywood 38, Calif.

Print No. Ins. 322 on Reader Service Card

Catalog on Engineering and Technical Article Review Service

Catalog describes an Engineering Index service which reviews each issue of over 1800 engineering and technological publications as they are issued. Each annotation is supplied on a 3" x 5" library card. Photostat or microfilm copies of articles are available. The accumulated engineering literature of 1960 is now being com-

plied for dissemination in a bound volume. The Engineering Index, 29 West 39th St., New York 18.

Print No. Ins. 333 on Reader Service Card

Catalog of D-C Equipment

A new two-color catalog describes a line of standard d-c power supplies and test instruments. Complete specifications are furnished and include ratings, features, dimensions, and weights of the individual equipments covered. 16 pages. The Opad Electric Co., 43 Walker St., New York 13.

Print No. Ins. 334 on Reader Service Card

Radiation Facilities Brochure

Brochure presents comprehensive exposition on the design and manufacture of a high voltage accelerator. It also pictures and describes Radiation Service Center, as well as facilities for research and development. Also featured are applications of the accelerator ranging from space environmental studies to a broad variety of industrial radiation uses. 8 pages. Radiation Dynamics, Inc., Westbury Industrial Park, Westbury, L.I., N.Y.

Print No. Ins. 335 on Reader Service Card

A problem in rubber insulation?

PELMOR HAS THE ANSWER!

ENGINEERED COMPOUNDS:

Highly specialized electrical insulations. Resistant to extreme temperatures, fuels, oils, chemicals, weather and ozone. Designed to meet exacting physical specifications.

MATERIAL BASED ON:

Fluorocarbons, hypalons, silicones, polyacrylics, neoprenes, butyls and general purpose rubbers.

PELMOR TECHNICIANS, serving a broad range of industries, are ready to supply you with mixed compounds, molded parts or solution coatings.

TESTING, RESEARCH AND DEVELOPMENT, DESIGN AND ENGINEERING SERVICES are also available.

Inquiries will receive immediate attention.

Write:

PELMOR LABORATORIES, Inc.

Newtown 1, Pennsylvania WOrth 8-3334

Print Ins. 56 on Reader Service Card

you can be sure...

If you insist on consistent, dependable service from a supplier of electrical porcelain, we suggest you check with STAR. When you place your order with STAR, you can be sure that it will be handled with top priority. You're sure, too, of receiving the finest quality materials, delivered when promised! Write us about your electrical porcelain needs whether large or small. You'll be glad you did.

The STAR Porcelain Company

34 MUIRHEAD AVENUE, TRENTON 9, N. J.

Print Ins. 55 on Reader Service Card

Moisture Dust Vibration Corrosion Operational hazards

Count on CIBA Epoxies
wherever conditions threaten
performance efficiency

Designers of electrical equipment choose epoxies for a wide variety of applications. When optimum performance is a must their choice is invariably a formulated product based on CIBA Araldite® Epoxy Resins. Adverse conditions that threaten the effective performance of a component are combatted most effectively with insulation *properly formulated* from these resins and specifically designed for the job at hand. As a result of many years' research and development at CIBA laboratories, formulators and end users alike have learned to depend on the high quality epoxy resins of CIBA for their particular projects.

Consult a CIBA representative who will assist you in obtaining the proper epoxy resin based insulating materials for dependable results time after time.

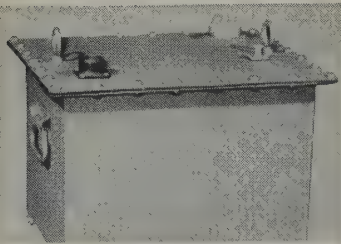
CIBA Products Corporation
Fair Lawn, New Jersey



CIBA
First in Epoxies

Print Ins. 65 on Reader Service Card

50 KV DC HV TEST SET



- Small size, light weight
- Rugged & reliable
- Low cost

Model S50-5DC is designed for dielectric testing, for leakage current measurements at high-voltage, and also used as a high voltage power supply for CRT work, electrostatic processes, sparking, corona generation, etc.

The oil-filled tank, less than 1 cu. ft. in volume, contains all HV components, metering facilities and automatic output shorting solenoid.

Selenium rectifiers are employed for ruggedness, long life and enhanced reliability. HV terminates in a shielded cable.

A fully instrumented control panel in cabinet or for rack mounting, not shown, provides all safety and convenience features.

The HV section pictured also available by itself without the control cabinet for use as a power unit.

Many other models available.

Telephone or write.

Peschel Electronics, Inc.

Phone TRinity 8-3251

Towners Patterson, N.Y.

Print Ins. 59 on Reader Service Card



GROMMETS ONE-PIECE NYLON

Simple Installation

- Snug fit—no rattle
- High static strength and retention characteristics
- Superior wear resistance without abrasion
- Excellent electrical properties
- Greatly simplify stocking. 4 basic lengths fit sheet gages from .025 to .250
- Grommet is merely inserted through aperture. A simple tool flares protruding shank until induced hoop stresses flip shank back on itself.
- No heat needed in installation.

Write or phone for name of nearest representative.

**WESTERN SKY
INDUSTRIES**

Dept. 1 • 21301 Cloud Way, Hayward, Calif.

Print Ins. 60 on Reader Service Card

Dates to Circle

Meeting and Convention Notices

Apr. 30-May 4 . . . Electrochemical Society, Spring Meeting, Claypool Hotel, Indianapolis, Ind.

Apr. 30-May 4 . . . Seventh National Aerospace Instrumentation Symposium, sponsored by ISA, Adolphus Hotel, Dallas, Texas.

May 1-2 . . . AIEE, Rural Electrification Conference, Kentucky Hotel, Louisville, Ky.

May 1-3 . . . AIEE, Appliance Technical Conference, Kentucky Hotel, Louisville, Ky.

May 2-4 . . . Electronic Components Conference, AIEE, IRE, EIA, and WEMA, Jack Tar Hotel, San Francisco.

May 7-8 . . . IRE, 5th Midwest Symposium on Circuit Theory, University of Illinois, Urbana, Ill.

May 8-9 . . . SPI, Nineteenth Canadian Section Conference, Sheraton-Brock Hotel, Niagara Falls, Ont., Canada.

May 8-10 . . . IRE, NAECON, Miami and Biltmore Hotels, Dayton, Ohio.

May 8-10 . . . Fourth National ISA Power Instrumentation Symposium, La Salle Hotel, Chicago.

May 9-11 . . . Western Joint Computer Conference, sponsored by AIEE, IRE, and Assoc. of Computer Manufacturers, Ambassador Hotel, Los Angeles.

May 17-19 . . . AIEE, North Eastern District Meeting, Statler Hotel, Hartford, Conn.

May 22-25 . . . ASME, Design Engineering Show and Conference, Cobo Hall, Detroit.

May 23 . . . AIEE, Fractional Horsepower Motors Conference, Dayton Engineers' Club, Dayton, Ohio.

May 24-26 . . . EIA, 37th Annual Convention, Chicago.

June 5-9 . . . SPI, Annual National Plastics Conference and Exposition, Commodore Hotel and the Coliseum, New York City.

June 8-9 . . . NEMA, Western Conference, The Biltmore Hotel, Los Angeles.

June 8-10 . . . Manufacturing Chemists' Association, Inc., Annual Meeting, The Greenbrier, White Sulphur Springs, W. Va.

June 11-14 . . . EASA, Annual Convention, Jack Tar Hotel, San Francisco, Cal.

June 11-15 . . . American Society of Mechanical Engineers, Semiannual Meeting, Statler-Hilton Hotel, Los Angeles, Cal.

June 18-23 . . . AIEE, Summer General Meeting, Cornell University, Ithaca, N. Y.

June 21-July 1 . . . International Plastics Exhibition and Convention, Olympia, London, England. Address inquiries to: Interplas '61, Dorset House, Stanford St., London S.E. 1, England

June 22-23 . . . The Wire Association, West Coast Regional Meeting, Jack Tar Hotel, San Francisco.

June 25-30 . . . ASTM, 64th Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

June 26-28 . . . 68th Annual Meeting, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Denver-Hilton Hotel, Denver, Colo.

June 26-30 . . . Western Summer Radio-Television and Appliance Market (Division of Western Home Goods Market), Western Merchandise Mart, San Francisco, Cal.

June 28-30 . . . Joint Automatic Control Conference, sponsored by AIEE, ASME, IRE, Instrument Society of America, and American Institute of Chemical Engineers, University of Colorado, Boulder, Colo.

June 29 . . . High Precision Connectors, National Bureau of Standards, Boulder Laboratories, Boulder, Colo.

July 18-20 . . . Western Plant Maintenance and Engineering Show, Pan Pacific Auditorium, Los Angeles.

July 27-Aug. 1 . . . International Symposium on Macromolecular Chemistry, Montreal, Canada. Address inquiries to: The Organizing Committee, International Symposium on Macromolecular Chemistry, P. O. Box 816, Sarnia, Ontario, Canada.

Aug. 22-25 . . . WESCON, The Cow Palace, San Francisco.

Aug. 23-25 . . . AIEE, Pacific General Meeting, Hotel Utah, Salt Lake City, Utah.

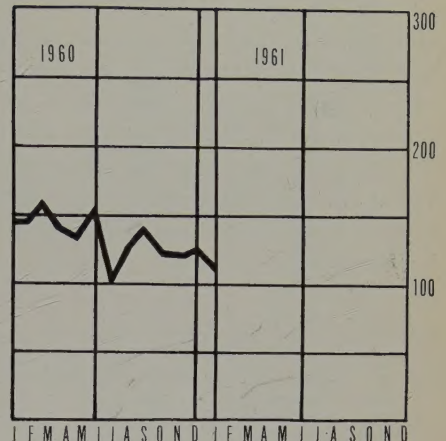
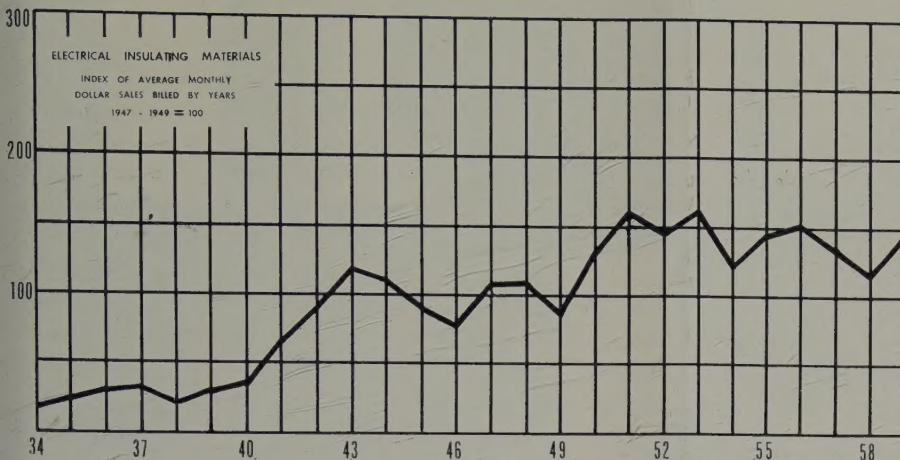
Sept. 12 . . . SPE, Plastics for Tooling, Retec sponsored by Central Indiana Section, Hotel Severin, Indianapolis, Ind.

Abbreviations Used in Notices

AIEE —American Institute of Electrical Engineers
ASTM —American Society for Testing Materials
ASME —American Society of Mechanical Engineers
ASA —American Standards Assn.
IRE —Institute of Radio Engineers
EIA —Electronic Industries Assn.

NEMA —National Electrical Manufacturers Assn.
EASA —Electrical Apparatus Service Assn.
SPE —Society of Plastics Engineers
SPI —Society of the Plastics Industry
WEMA —Western Electronic Manufacturers Assn.

NEMA Electrical Insulation Index



Jan. '61 Dec. '60 Jan. '60

Index Series	118	130	146
Jan. '61 point change from other mos.	-12	-28	
Jan. '61 % change from other months	-9	-19	

Index is based on 1947-1949 average month, inclusive=100

Published through the courtesy of the National Electrical Manufacturers Association

Materials Used in Electrical Insulation Index

Industrial Laminated Products
Manufactured Electrical Mica
Flexible Electrical Insulation
Vulcanized Fibre
Coated Electrical Sleeving

ALL YOUR INSULATION NEEDS



centrally
located
for quick
service



Armature Twines, Wedges
Bi-Seal Tapes
Coil Winding Machines
Cotton Tapes and Webbing
Cotton Sleeveings
Commutators
Cuffed Insulating Papers
Extruded Plastic Tubings
Fiberglass Tapes, Cords and Sleeveings
Friction and Rubber Tapes
Insulating Varnishes and Compounds
Low-Pressure Laminates
Magnet Wire
Mica-Built-up and Raw
Motor Enamels
Pressure Sensitive Tapes
Safe-T-Seal
Silicone Rubber Extruded Tubings
Silicone Rubber Coated Fiberglass Tubing
Silicone Wedges
Teflon Tapes and Tubings
Undercutting Machines and Saws
Varnished Sleeveings and Tubings—Cotton, Fiberglass and Rayon
Varnished Cambric, Paper and Tapes
Vinyl Fiberglass Tubings and Sleeveings
Vinyl Tape
Wire Brushes
Wire Markers

J. J. Glenn and Company

605 West Washington Blvd., Chicago 6, Ill.
State 2-9669

4629 Rumpke Road, Cincinnati 45, Ohio
Plymouth 2-3709

7915 N. Boyd Way, Milwaukee 17, Wis.
Flagstone 2-7262

write for
handy
Glenn
reference file

Print Ins. 61 on Reader Service Card

RAYON NYLON YARNS



**Natural and Dyed
For the Wire Trade**

All Types of Put-Ups and Constructions
to your specifications

**Atlantic
Yarn Corporation**

125 WEST 41st ST., NEW YORK 36, L Omgacre 3-4200
PLANT: 86 CRARY ST., PROVIDENCE 1, R. I.

Print Ins. 62 on Reader Service Card

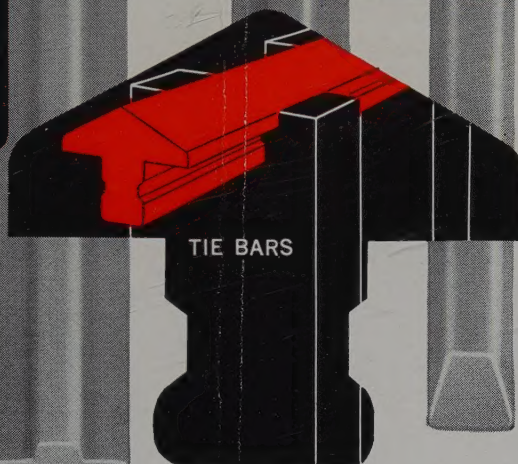
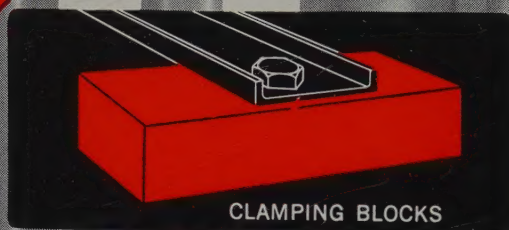
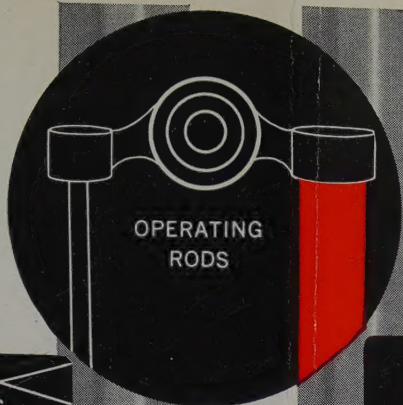
Advertisers' Index

To obtain more information on products of Insulation advertisers, just print the advertisement number shown for each advertiser in one of the spaces on the Reader Service Inquiry Card on the inside back cover. This number appears under each advertisement and is also repeated in the listing below. After filling out the card completely, tear it off and drop it in the mail—no postage required. Insulation will promptly forward your requests for further information to the advertisers.

Number	Advertiser	Page
Ins. 64	Aluminum Co. of America, Rea Magniet Wire Co., Inc., Div.-----Outside Back Cover	
Ins. 10	American Enka Corp., Wm. Brand-Rex Div.-----	16
Ins. 48	Anaconda Wire & Cable Co.-----	85
Ins. 62	Atlantic Yarn Corp.-----	97
	Belden Manufacturing Co.-----	65
Ins. 1	Bentley-Harris Manufacturing Co.-----Inside Front Cover	
Ins. 38	The Blane Corp.-----	75
Ins. 33	E. J. Cady & Co.-----	68
Ins. 16	Catalytic Combustion Corp., A Subsidiary of Universal Oil Products Co.-----	29
Ins. 65	Ciba Products Corp.-----	95
Ins. 29	Coast Mfg. and Supply Co.-----	62
	Continental-Diamond Fibre Corp., A Subsidiary of the Budd Co.-----	83
Ins. 15	Cottrell Paper Co., Inc.-----	28
Ins. 11	Crocker, Burbank Papers Inc.-----	17
Ins. 9	J. P. Devine Mfg. Co.-----	15
Ins. 5	Dow Corning Corp.-----	6 & 7
Ins. 17	E. I. du Pont de Nemours & Co. (Inc.), Film Dept.-----	33
	Employment—Help Wanted-----	63
Ins. 27 & 40	Enjay Chemical Co., A Division of Humble Oil & Refining Co.-----	59 & 77
Ins. 36	Essex Wire Corp., Magnet Wire Div.-----	73
Ins. 12	Food Machinery and Chemical Corp., Epoxy Dept.-----	18
Ins. 30	Furane Plastics, Inc.-----	63
Ins. 22	General Electric Co., Insulating Materials Dept.-----	49 & 50
Ins. 49	General Electric Co., Silicone Products Dept.-----	87
Ins. 63	The Glastic Corp.-----Inside Back Cover	
Ins. 61	J. J. Glenn and Co.-----	97
Ins. 53	Gudebrod Bros. Silk Co., Inc., Electronic Div.-----	92
Ins. 37	Hess, Goldsmith & Co., Inc. Horace Linton Div.-----	74

Number	Advertiser	Page
Ins. 44	Hudson Wire Co., Ossining Div.-----	81
Ins. 45	Hull Corp.-----	82
Ins. 57	The Huse-Liberty Mica Co.-----	60
Ins. 19	Ilumitronic Engineering-----	43
Ins. 51	Industrial Instruments, Inc.-----	90
Ins. 3	Insulation Manufacturers Corp.-----	2
Ins. 26	Johns-Manville, Industrial Insulations Fiber Glass Div.-----	57
Ins. 25	L. Frank Markel & Sons-----	56
Ins. 18	Midwest Molding & Manufacturing Co.-----	41
Ins. 42	Milam Electric Mfg. Co.-----	79
Ins. 52	Minnesota Mining & Manufacturing Co., Irvington Div.-----	91
Ins. 34	Monsanto Chemical Co., Plastics Div.-----	69
Ins. 14	Narmco Materials, A Subsidiary of Telecomputing Corp.-----	28
Ins. 21	National Vulcanized Fibre Co.-----	47
Ins. 6	Natvar Corp.-----	9
Ins. 58	Newbury Industries, Inc.-----	60
Ins. 7	New Jersey Wood Finishing Co.-----	11
Ins. 56	Pelmor Laboratories, Inc.-----	94
Ins. 20	Pennsylvania Fluorocarbon Co., Inc.-----	45
Ins. 59	Peschel Electronics, Inc.-----	96
Ins. 23	Phelps Dodge Copper Products Corp., Inca Manufacturing Div.-----	52 & 53
Ins. 35	Plymouth Rubber Co., Inc.-----	71
Ins. 2	Prehler Electrical Insulation Co.-----	1
Ins. 43	Raybestos-Manhattan, Inc., Plastic Products Div.-----	80
Ins. 4	Rayclad Tubes Inc., A Subsidiary of Raychem Corp.-----	5
Ins. 28	The Richardson Co.-----	61
Ins. 47	Riegel Paper Corp.-----	84
Ins. 8	Shawinigan Resins Corp.-----	13
Ins. 13	Spaulding Fibre Co.-----	24
Ins. 55	Star Porcelain Co.-----	94
Ins. 24	J. P. Stevens & Co., Inc.-----	55
Ins. 32	Sylvania Electric Products Inc., Parts Div.-----	66
Ins. 54	Taylor Fibre Co.-----	93
Ins. 50	Union Carbide Corp., Union Carbide Plastics Co. Div.-----	89
Ins. 41	Varflex Sales Co., Inc.-----	78
Ins. 60	Western Sky Industries-----	96
Ins. 39	West Virginia Pulp & Paper Co.-----	76

Advertising Sales Offices:
Libertyville, Ill.—(General Offices) P.O. Box 270, 311 E. Park Ave. Phone EMpire 2-8711
Chicago 11, Ill.—Philip Holmes and Robert D. Foran
 410 N. Michigan Ave. Phone WHitehall 4-2883
Detroit 26, Mich.—Charles R. Schroeder
 413 Lafayette Bldg. Phone WOodward 1-0278
New York 20, N.Y.—Robert Bandini and Roland Robitaille
 1 Rockefeller Plaza, Phone Clrcle 6-4712
Pacific Coast—H. L. Mitchell & Assoc., 1450 Lorain Road,
 San Marino, Calif. Phone CUmberland 3-4394
 (Central California only—James T. Stevenson, 5901 Buena Vista
 Ave., Oakland 18, Calif. Phone OLYmpic 3-8602)



GLASTIC FIBER GLASS ROD

**Compare Properties, Compare Prices...
See Why It's Best for Jobs Like These**

Use Glastic fiber glass reinforced polyester rod wherever you need insulating structural, operating or spacing material. Glastic MTS extruded rod has continuous fiber glass filaments that run its entire length—giving flexural strength of 50,000 psi. It has the excellent corrosion resistance, dimensional stability and electrical properties typical of fiber glass polyester.

Compare its cost with the material you are presently using. For example, 5000 feet of 1/4 inch round rod costs less than 6 1/2 cents per foot. That's considerably less than lower temperature mate-

rials such as molded phenolic or fibre rod—even less than some rigid tubing. The smooth molded finish and good dimensional tolerances may eliminate subsequent machining and finishing costs. Standard length is 8 feet to give you a better yield, and special longer lengths as well as cut pieces are available.

There are a large number of stock sizes—9 round rods through 1" diameter, 15 square and rectangular rods through 1 3/8" wide, and 9 special shapes. Custom shapes may be tooled for costs comparable to aluminum extrusion dies.

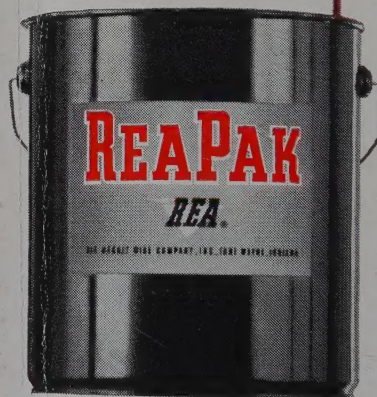
Send for engineering-price data and samples.



THE GLASTIC® CORPORATION

4321 Glenridge Road • Cleveland 21, Ohio

Print Ins. 63 on Reader Service Card



Ask your Rea man about versatile POLY-THERMALEZE... for 155°C operation

He'll describe an improved polyester magnet wire that offers increased resistance to abrasion, solvents and heat shock . . . while retaining vital moisture resistance characteristics. Rea POLY-THERMALEZE* is a Class F (155°C) polyester-film, insulated wire available at the cost of standard Class A (105°C) magnet wires. Thus, it is applicable to either Class A (105°C), Class B (130°C) or Class F (155°C) electrical apparatus. Rea POLY-THERMALEZE embodies an unusually good combination of physical, chemical, thermal and electrical characteristics. And it's available in the famous ReaPak® container or standard spools and reels. Call your Rea man today—or write to us in Fort Wayne for samples and more information.

*Licensed by Phelps-Dodge Copper Products Corp.

REA

Copper and
Aluminum Magnet Wire,
All Insulations

REA MAGNET WIRE COMPANY, INC. • Division of Aluminum Company of America • Dept. 1930-E, Fort Wayne, Indiana • TWX: FW

Print Ins. 64 on Reader Service Card